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AUTOMATION AND MANAGEMENT

THE report on the technical trends of automation and their impact on management and labour which the Department of Scientific and Industrial Research has prepared*, and on which the two major political parties in the House of Commons congratulated the Department on May 17, does not add significantly to our technical knowledge of automation. It is important, nevertheless, first as helping to minimize the dangers which attend the misunderstandings of the nature and implications of automation and which have already led to its becoming something of a bogey word; and secondly, it gives a convenient summary of the present position of our knowledge of the expansion of the scope of mechanization, of the development of techniques of automatic control and especially of the application of the electronic digital computer to the automatic processing of technical information and more particularly of the social and human problems which are involved both for managers and for the trade unions. In this context, the Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities within the Commonwealth and Empire to be held in Oxford during July 9–27 assumes additional importance.

All these meanings are popularly given to automation, and the report accordingly covers all technical developments that make automatic production more possible. Although the confusion between these different meanings has been responsible for misunderstandings and for some opposition to what is essentially a development that has been in progress for centuries, the report should clarify some at least of the confusion and help to abate tension. Automation is put into its proper historical perspective. In so far as, like the Minister of Labour in his broadcast on May 4, we restrict its meaning to "machines looking after machines", it only represents the third of three continuous and overlapping phases in the development of modern industry. The electronic digital computer, by facilitating the rapid and automatic processing of business information, has extended automatic control to complex manufacturing operations and commercial offices. The pace of development has been accelerated; but the principle and techniques of automatic control were already being developed and applied to manufacturing processes over a widening range of industries. In its turn, such automatic control both followed and proceeded simultaneously with the earlier phase of line production in which advanced techniques of handling materials and products and assembling components had extended the scope of the earlier phase of mechanization.

It is the scale of future developments that has made automation something of a bogey. It is already possible to envisage a large and complex, yet fully automatic, factory in which a computer integrates and controls the separate automatic production lines, and almost certainly striking developments in automatic control will come from units incorporating computers. The potential scale of such developments and the economy in labour they seem to offer are reasons for the present concern; the fact that they affect primarily those industries which are turning to mass production and, in thus offering mass consumption, are most sensitive to fiscal and economic policy, is another. The third and most important reason is psychological, arising in part from the shadow cast upon full employment and in part from inherited prejudices and imperfectly understood events of the past.

The report begins by looking at automation in historical perspective, and briefly outlining the conception of automatic production with two examples, one a piston factory in the U.S.S.R., and the other a building-board factory in the United Kingdom. These examples represent the converging of two or more developments; but current progress is mainly in separate streams—transfer machines, mechanical handling and assembly, automatic control of machinery and processes, and clerical work by electronic computers. These all help to make more processes automatic, but do not integrate them and thus do not fulfil the concept of fully automatic production. The present position is accordingly indicated in a chapter on the technical trends, which examines separately developments in automatic machinery, including the control of machine tools by electronic methods in automatic process control, and in the automatic processing of data.

In this chapter some of the future possibilities are discussed; but they are considered more fully in the succeeding chapter on the extent and rate of development. Control equipment in a new chemical plant or petroleum refinery may represent as much as 20 per cent of the entire capital equipment in terms of cost, and in future it should be possible on an electronic computer to integrate with the direct control of all variables in the process and plant the time-consuming calculations needed to assess the effects of deliberate changes in operating conditions, raw materials and plant characteristics. Moreover, if the present trend is followed, much process control of the future will be based on the measurement of quality in the final product, though not until techniques of instrumentation are much further advanced. While computers will almost certainly be introduced gradually in offices, it can already be assumed that there is much scope for them; but their use will call for careful re-examination of office routines and may change them in many ways, not only replacing clerical staff but also permitting the production of data that could not be obtained in time to be useful before, if obtainable at all.

The report suggests that, while it is uncertain how far and how fast automation will proceed, many

* Department of Scientific and Industrial Research. Automation: a Report on the Technical Trends and Their Impact on Management and Labour. Pp. viii+106. (London: H.M. Stationery Office, 1956.) 6s. net.

industries will adopt automatic techniques of production in one form or another. Neither size of firm nor availability of capital appears to be a principal restriction, though progress is likely to be most rapid in the bigger firms with the advantages of larger-scale production and bigger financial resources. The most decisive factor is likely to be the shortage of trained managers, engineers and technicians, partly because of the increasing technical complexity of industrial production and partly because of the existing shortage of scientists and technologists. Indeed, the report goes so far as to suggest that a major reappraisal of university and vocational training in Britain may be needed.

That conclusion emerges equally clearly in the chapter which considers the impact on management. This chapter and the succeeding one, which discusses the impact on labour, may well be the two most important in the book. They both point to the imperfections of present knowledge of the economic and social aspects of automation when compared with knowledge of the technical possibilities, and to the vital need of extending knowledge of these aspects by research and exchange of experience. Here, particularly, however, the report is not entirely uninhibited, and it is difficult to believe that its authors have been so lacking in discernment as might be suggested by the absence of comment or suggestions for inquiry into, for example, the problems of trade union demarcation that any wide programme of re-training adult workers is bound to encounter, or the new flexibility in union rules and in some employers' recruitment policies that will be required. Such lacunæ are the more obvious when the list of suggested subjects for research into the social and economic aspects is examined. The recent work of B. C. Roberts, J. A. Mack, H. A. Clegg and A. Flanders, and of others like N. S. Ross and R. Harle, writing in the recent special issue of *The Political Quarterly*, has shown how, if the trade unions are to adapt themselves to fulfil more effectively their new role in the Welfare State, it must be as a result of inquiry and reform from within. It will not be secured, however, by ignoring necessity for change and inquiry, or by failing to point out the directions in which they are required; and the report is notably weak in throwing on management the whole responsibility for difficulties attendant on the introduction of automation, and also in its reluctance to point out directions in which the co-operation and support of the workers are no less essential.

Except in relation to the new skills required, the chapter on labour does not draw any general conclusion pointing to responsibilities on the part of trade unions or workers. Operators on present-day automatic processes need no advanced technical training; but they must learn to understand their processes and machines. They may need more or less skill than formerly; but there is rarely a sharp break with existing skills. The evidence suggests that the new operative skills can be acquired through a moderate degree of training on the job. On the need for flexibility, the report is silent; but it suggests that automation is likely to provide real substitutes for satisfactions which have already disappeared from jobs that it is likely to eliminate. The operator will often see more of the process, receive a wider range of technical information, because he must understand how his own job fits in with others on the same process, and in these and other ways his work is likely to be more interesting. This may be the more important in that by calling for educational qualifications in a great proportion of jobs, automation may make it more difficult to advance merely through experience gained on the job.

The new technical and managerial skills—including those of programmers, 'systems' engineers, maintenance craftsmen and more highly trained managers—are less easily acquired. If they are taken into account, the general level of skill will tend to rise in the sectors of industry affected by automation, especially where routine clerical work is taken over by electronic digital computers. In some industries even supervisors may require qualifications that can only be obtained at educational institutes, and the report emphasizes the importance of firms seeking to train and promote the potential managers and technicians of all grades who are still in the ranks. Moreover, co-operation among technical specialists, and between them and managers, on one hand, and maintenance craftsmen and operatives on the other, becomes increasingly important; technical co-operation with maintenance men and technical management may provide a new social satisfaction for the operatives on automatic processes, who are often spread thinly over a big area and may find in keeping the machine-line or process running a satisfaction they might formerly have found in membership of an operative team.

The bearing of all this on the expansion of technical education is obvious. The implications for educational policy are no less important, and the report as a whole emphasizes the vital importance of planning educational expansion as a unity. If qualities like versatility, adaptability and the capacity for understanding other points of view look like being increasingly valued in managers and professional staff, in a lesser degree they are called for in others also. Consultation with the trade unions in advance of each step and the most careful attention to the needs, feelings and problems of the workers concerned will not ease the transition to automation if the workers are unwilling or unable to respond and are incapable of seeing the problem against the perspective of the position of the industry and the needs of the nation as a whole rather than of any one section of it.

So far as factory management is concerned, automation greatly increases the need for planning in order to minimize the technical inflexibility of highly integrated plant, to establish maintenance aiming at preventing faults, thus minimizing stoppages and achieving a high and constant rate of output, and providing for continuous running of machinery. Existing techniques of management may need to give way to new techniques that suit automatic processes, as, for example, in the systematic study of operations, the use of computers and the control

of costs. Again, the necessary changes in operative skills will be made more smoothly if they are carefully planned, if proper provision is made for training on the job, and if workers are consulted and kept well informed of likely developments. Moreover, wise management offers the best hope of surmounting difficulties in persuading workers to accept the shift-work essential for continuous running and in maintaining the workers' interest in the job without the regular social contact which the traditional operative teams afford.

These aspects of the tasks of management under the impact of automatic techniques of production show how important it is that technological education should be broadly based, and associated so far as possible with those types of courses which in the past have proved so successful in developing administrative ability and the capacity for initiative, the acceptance of responsibility and powers of leadership. If the need for communication and co-operation in industry is greatly increased, as this report suggests, excessive specialization in order to provide technical knowledge may be a danger rather than a help unless these qualities are safeguarded. Vision and imagination as well as versatility and adaptability will be required, if management is to soften the impact of automation on labour. All grades of management will indeed require fuller knowledge of the technical factors that influence their decisions; and while it will be more important than ever to plan the construction of a new plant well in advance, such planning must take account not merely of the technical complexities and aspects of production, but equally of the problems of organization of labour, including the planning of man-power requirements and the avoidance of redundancies where possible by utilizing, for example, natural wastage and labour turnover.

A number of the suggestions for research appended to the report are relevant to problems of management. For example, there is research into the economics and social implications of shift-working, on which a start has already been made at the Universities of Sheffield and Cambridge. At the South-East Essex Technical College and at the University of Edinburgh, work has already been started into the forms of management structure and organization most effective with automatic processes; but other work is suggested into the new techniques of management required by automation and into methods of planning man-power requirements, for example, the planning of innovations to coincide with natural fluctuations in the labour force.

Like other developments that increase the complexity of techniques of production, automation makes it essential that scientists and technologists should be given their right place in management, because technical considerations affect an increasing number of policy decisions on investment and on the routine operation of plant. Managements require a broad understanding of the new principles emerging from scientific and technical developments, and technologists and scientists require a clearer understanding of the economic and other managerial factors involved in implementing technical views. The report itself suggests that scientists and technologists are likely to be found at board-level more frequently than in the past, and some functional departments will increase in importance. It also queries the suitability in automation of the 'line-and-staff' principle of responsibility, though more by way of a matter for inquiry.

Much of this has been urged by Dr. P. V. R. Venables, by Sir John Cockcroft in his address to the Institute of Physics last April on "Science and Technology in Industry" and by others; both the Rector of the Imperial College of Science and Technology and the Principal of the Manchester College of Technology have indicated that the projected expansion at both Colleges is planned to provide technologists of the outlook and calibre demanded. Lord Heyworth again, at the annual meeting of Unilever, Ltd., on May 24, specially stressed the importance of good managers in industry, devoting most of his speech to their selection, background and training. If the Department of Scientific and Industrial Research's report on automation in the first place points to the urgent need for inquiry into the human and social aspects of automation, it equally presents the problem of finding managers of to-morrow of the requisite competence as one of the leading questions of the day. The report will have served its purpose if it brings the Government to a belated appreciation of the critical importance of that question.

As already emphasized, the report, however, also demonstrates the importance of looking at the expansion of education as a whole. It shows how vitally important to the economic and industrial future of Britain is the expansion not merely of technological education but also of technical education, and as a corollary the public understanding of technological change and what it involves. The Government has done well, as indicated in the reply of the Parliamentary Secretary to the Ministry of Labour and National Service to a question in the House of Commons on May 29, to promote the publication of a simplified version of the report for wide circulation, and there is much more needed to remove misunderstandings and fears of redundancy while the National Joint Advisory Council is considering the implications of the report itself. But the Government cannot rest there. It should be implementing, on an adequate scale, from our own resources and not merely from funds provided by American generosity, the researches into the economic and social aspects of automation which the report suggests. Even more important, it should be handling the educational issues with real determination and imagination, and no longer allow prejudice and tradition to impede the formulation and execution of a national policy adequate alike in scope, in content and in the resources with which it is provided. Lastly, the Government should be facing the issues involved in re-training and mobility of labour, so that its assistance policies do not subsidize under-employment and resistance to change but afford real help to those affected in the difficult period of transition from one job to another.

GEORGIUS AGRICOLA

Georgius Agricola 1494–1555 zu seinem 400 Todestag, 21 November 1955

(Deutsche Akademie der Wissenschaften zu Berlin.) Pp. 376+23 plates. (Berlin: Akademie-Verlag, 1955.) 38 D. marks.

De Natura Fossilium (Textbook of Mineralogy)

By Georgius Agricola. Translated from the First Latin Edition of 1546 by Mark Chance Bandy and Jean A. Bandy. (Geological Society of America Special Paper 63.) Pp. xiii+240. (New York: Geological Society of America, 1955.) 3 dollars.

THE four hundredth anniversary of the death of Georgius Agricola[1] (1494–1555) has been marked in Eastern Germany by the publication, under the auspices of the German Academy of Sciences at Berlin, of a commemorative volume containing twenty-five essays concerning various aspects of his life, work and times. Agricola was a man of varied accomplishments—one of the great scientists of the sixteenth century and also physician, scholar and diplomat—and these essays should have a wide appeal.

It is impossible, within the limits of a short review, to do more than refer briefly to the subject-matter of individual essays. The first, by Prof. Leo Stern, of Halle, is of an introductory character, dealing generally with Agricola's life and mentioning the many contemporary scholars whose work in some way impinged on his. Other essays cover particular periods in his life, and one which calls for special mention is the account, by Dr. Helmut Wilsdorf, of Freiberg, of Agricola's *Wanderjahre* in Italy and some of the English scholars whom he may have met there. The contemporary background is also discussed in articles on mineral collectors and collections of the sixteenth century, and on the songs of the miners; and a brief account of the miner and his work as delineated in contemporary art is accompanied by a number of attractive plates. One of these illustrates the beautiful frontispiece of the famous "Kuttenberger Kanzionale" (a manuscript volume of old songs in the possession of the Vienna National Library), depicting the whole gamut of mining activities, from the miner deep in the mine to the eager shareholders receiving their profits. Both this plate and that of the miners' altar at Annaberg would have gained immensely by reproduction in colour.

Many of the contributions are reviews, by experts, of different chapters in Agricola's most famous book, the "De Re Metallica". These deal with subjects such as mining law, mine machinery, ore-dressing, metallurgy and surveying in the sixteenth century. Among them is a valuable contribution by Dr.-Ing. P. Beyersdorfer, a glass technologist, comparing the account of glass manufacture given by Biringuccio in his "Pirotechnia" (1540) with that given by Agricola. A well-illustrated article on the woodcuts in the "De Re Metallica", by Dr.-Ing. W. Pieper, includes a reference to the suggestion, recently made by Dr. H. Prescher, that Agricola himself is represented in one of the woodcuts depicting tin-smelting, by a figure industriously writing in a note-book (p. 415 in the Hoover (1912) translation).

There are several essays on the influence exerted by the work of Agricola on mining in neighbouring countries, including one on the development of mining in Russia from the sixteenth to eighteenth centuries. This stresses the value attached to Agricola's writings by the great Russian scientist Lomonossov.

Agricola published all his specifically geological and mineralogical writings together in one volume, in 1546, the work being generally known by the title of the first part, "De Ortu et Causis Subterraneorum". The contents of this volume have unfortunately received much less attention than they deserve. Dr.-Ing. Walther Fischer, in an essay entitled "Agricola, Father of Mineralogy", discusses the valuable contributions to mineral science found in "De Natura Fossilium", the third section of this volume, and also mentions some of Agricola's opinions on such subjects as volcanoes, earthquakes and ore-genesis; but one could have wished for a fuller treatment of these subjects. Another section in the same volume, with the title "De Veteribus et Novis Metallis", a valuable historical account of mines, is discussed in a second essay by Dr. Wilsdorf, who advances the claim that Agricola laid the foundation for a history of mining.

Other aspects of Agricola's life are described in articles on his work as physician, on his books on money and on weights and measures, and on his services as burgomaster of Chemnitz (now known as Karl-Marx-Stadt). The volume also includes an annotated record of Agricola's known correspondence, published and unpublished, with a reproduction of his handwriting. There is no index, and the volume ends with a somewhat over-elaborate table of the various editions of Agricola's numerous publications. This is useful, but its value would have been greatly enhanced if more bibliographical details had been given.

This commemorative volume is of especial value as a detailed study of mining and related activities in central Europe during the sixteenth century, but it should also have a considerable appeal to all interested in the development of science during that period.

In America, an appreciation of early mining and metallurgical classics has been manifest for a number of years. This interest was first stimulated by the publication of the well-known translation of Agricola's "De Re Metallica" by the Hoovers in 1912. Since then there have come in succession from the United States scholarly translations of A. A. Barba's "Arte de los Metales", of Biringuccio's "Pirotechnia", of early sixteenth-century editions of the mining and assaying works known as the "Bergbüchlein" and "Probierbüchlein", respectively, and of Lazarus Ercker's "Treatise on Ores and Assaying". Now the Geological Society of America has entered this field by publishing a translation, by M. C. and J. A. Bandy, of Agricola's "De Natura Fossilium". The translation has been made from the first edition, published in 1546, and not from the second edition, which was enlarged by Agricola himself, although not published until 1558, three years after his death. This treatise on minerals forms the third section in the volume of Agricola's geological and mineralogical writings mentioned above, and in it the term "fossilia" is used to include anything inorganic dug out of the earth. We find, therefore, not only accounts of minerals, but also of clays, and their use by potters and sculptors, of marls, and their use by farmers, of bricks, marbles, and even of incinerary urns. Although Agricola frequently quotes Pliny and other early authors, he adds many interesting comments of his own, such as "Within the year thirty-five buildings in Magdeburg have had lead roofs put on them", a statement which

suggests this book might be of interest to economic historians.

While this translation is most welcome, one misses the many scholarly notes that form so valuable a part of the Hoovers' work. Many of their notes do, in fact, refer to the "De Natura Fossilium", and some cross-reference to them would have been useful to the reader. However, a number of explanatory footnotes have been included with this translation, as well as indexes of mineral names in English, Latin and Greek. There is, unfortunately, no index of place-names. A few misprints and errors have been noticed, such as "agate" on p. 18, line 33, for "aetites".

This little volume should have a wide circulation, and it is to be hoped it will be followed by translations into English of other works by Agricola, particularly the "Bermannus" of 1530, of which a new German translation, by Dr. Wilsdorf, appeared as recently as 1955.

JOAN M. EYLES

[1] See *Nature*, **176**, 949 (1955).

WISCONSIN SYMPOSIUM ON SOLAR ENERGY, 1953

Solar Energy Research

Edited by Farrington Daniels and John A. Duffie. Pp. xv+290+11 plates. (London: Thames and Hudson, Ltd., 1955.) 30*s*. net.

RESEARCH on the utilization of solar energy has received a very great impetus as a result of conferences that have been recently held in Arizona (see *Nature*, Jan. 21, p. 110). This book is a record of the proceedings of an earlier conference organized by Prof. Farrington Daniels at the University of Wisconsin, Madison, in September 1953. Though less ambitious than the Arizona meetings, the Madison conference offered the first opportunity for many of those actively engaged in solar research to come together and discuss their problems. The book consists of a series of chapters written by those attending the conference or invited to contribute, and covers most of the aspects of the utilization of solar energy. These may be summarized briefly under the following headings: collection of solar radiation in the form of low-grade heat (that is, below the normal boiling point of water, as used for water and house heating, and water distillation); concentration of the radiation by mirrors to produce high temperatures for melting metals and refractory materials; conversion of radiation to electricity, either by thermoelectric methods with heat as an intermediate stage, or by photovoltaic effects; photochemical effects in which the equilibrium of a chemical system is changed by the action of light; and photosynthetic processes through living plants.

An introduction by Prof. Farrington Daniels explains the object of the conference and is followed by a section on probable world energy demands in the future, in which P. C. Putnam predicts that in a hundred years time solar heat collectors might supply nearly 10 per cent of the world's demand in the form of low-grade heat, though only 0·1 per cent in the form of power. Incidentally, 60 per cent is quoted for nuclear fuels and 25 per cent for fossil fuels. Knowledge of the influence of meteorology on solar radiation and measurement of solar radiation are essential for a study of applications, and these factors are discussed in the succeeding chapters.

The nine chapters which follow collate papers on space heating and domestic uses of solar energy, solar power, solar evaporation and distillation, atmospheric phenomena and conversion of solar to electrical energy, solar furnaces, photosynthetic and photochemical utilization of solar energy, the British point of view, and miscellaneous applications and suggestions for further work. An appendix by Dr. John A. Duffie, of the University of Wisconsin, contains a survey of United States patents on the subject and a bibliography. Most of the sections consist of three or four papers by well-known research workers on the subject, and describe in a clear and lucid manner the present state of knowledge and the future possibilities.

The object of the symposium was to summarize the situation regarding the utilization of solar energy, and it is possible that the recent world conference in Arizona was, in some respects, promoted by the interest aroused at this earlier meeting. Many people with thoughts on the future development of world energy resources are inquiring about the possibilities of utilizing solar energy directly. The contents of this book appear to have been arranged for the express purpose of explaining these, and are written in an easily readable style with adequate illustrations. The complete volume gives the best outline at present available of activities in the utilization of solar energy.

THERMODYNAMICS FOR CHEMISTS AND CHEMICAL ENGINEERS

The Principles of Chemical Equilibrium, with Applications in Chemistry and Chemical Engineering

By Prof. Kenneth Denbigh. Pp. xxi+491. (Cambridge: At the University Press, 1955.) 42*s*. net.

AN understanding of thermodynamics is essential for all who are concerned with quantitative aspects of chemical processes, and yet most students find its concepts too abstract for rapid assimilation. A major difficulty is that the link between thermodynamics and the familiar and easily comprehended molecular theory is statistical mechanics, and most teachers, and apparently most authors, are of the opinion that the student is even less receptive to this subject. The order of presentation of most courses of physical chemistry is therefore molecular theory, thermodynamics and, finally, statistical mechanics. One wonders whether the problem of presentation is not the root of the vast number of books on thermodynamics and whether this spate of texts, each one of which may have a different emphasis, approach and nomenclature, is not a further barrier to the understanding of the often benumbed student. Every teacher of this fascinating and fundamental subject must be assailed by doubts of this kind when he opens the pages of yet another volume.

None the less, Prof. Kenneth Denbigh's book is a welcome addition to the multitude. It is intended for students in their final year of a chemistry or a chemical-engineering degree course, who have already had some acquaintance with the elementary parts of the subject. The first part (100 pages) introduces the first and second laws, the usual thermodynamic

functions and conditions of equilibrium, while the second (214 pages) is concerned with the application to gases, gaseous equilibria, phase equilibria and solutions. The approach throughout is properly based on the chemical potential, and the treatment, always adequate, is at times illuminating. The student who works through these chapters will be amply rewarded; but work he will have to, for although care has been taken to ensure clarity, the style is at times ponderous and he may well get the impression that the subject is more difficult than it really is. He will be helped, however, by the illustrations in the text and by the graded problems at the end of each chapter—a very valuable feature of the book. Only by submitting himself to the rigid discipline of working examples does the student begin to appreciate the value and versatility of the thermodynamic tool and to acquire the confidence to use it in attacking practical problems. The chemistry student will find the treatment of cells and electrolytes too brief and will regret the exclusion of surface phenomena. The third part (150 pages), devoted to statistical mechanics, contains interesting chapters on the statistical analogues of entropy and free energy, the partition functions of gases, and crystals and the third law, but the beginner may find them above his head. The two final chapters, one giving a brief treatment of regular solutions and adsorption, and the other on some aspects of chemical kinetics, might well have been replaced by a statistical treatment of chemical equilibrium, which receives only scant attention. There is even no mention of the functions $(G^0-H^0_0)/^0T$ and $(H^0-H^0_0)$ and of their use.

Prof. Denbigh's book will be useful to the brighter students and to teachers of the subject; but those applied chemists and chemical engineers who wish to be led gently up the thermodynamic slope may seek a less strenuous guide.

TOWARDS THE NEW CYTOLOGY

Physiologie der Zelle

Von Dr. Johannes Haas. Pp. 474. (Berlin-Nikolassee: Gebrüder Borntraeger, 1955.) 48 D.M.

THE need for a text-book presenting an integrated account of cell organization in the light of developments of the past twenty-five years has for some time been evident, and Dr. J. Haas's book goes a long way towards satisfying this need. The modernity of its approach is indicated by an initial section on molecular morphology, accounting for about one-third of the volume. There is to this extent a certain parallel with Frey-Wyssling's book, "Submicroscopic Morphology of Protoplasm and its Derivatives"; but there is a wealth of difference between the two, for the emphasis in Dr. Haas's book is primarily biochemical. Within the compass of a hundred and sixty pages he examines the structure and properties of proteins, nucleic acids, enzymes and lipoids, and then proceeds to a consideration of cell organelles: cytoplasm, cell surface, mitochondria, nucleus and interphase-chromosomes (119 pp.). In a third section he discusses selected cell functions: respiration, exchanges with the environment, cell division, growth and differentiation (155 pp.).

The extent to which the author has succeeded in integrating a work of this scope is highly commendable; but he has not managed to avoid repetition. It would be easy to draw up a list of references missed, and for British and American readers there will be some shocks; but these omissions do not impair the over-all achievement. They are more than offset by the number of references which will be new to many readers.

On a different plane of criticism, one may perhaps regret that Dr. Haas seems not entirely conscious of the revolution in ideas which has occurred and of which he displays the results. He states (p. 17) that the object of physiology is the study of function in its dependence on organic structure prevailing at a given time. It is to be doubted whether any physiologist of thirty years ago would have so expressed his aim; and there are probably many physiologists to-day who will be surprised by such a definition. For cell physiology, the definition is a concise statement of present aims; but Dr. Haas allows it to pass as if it were a commonplace. Related to this lack of historical awareness is a more serious criticism—the more serious since this book is clearly a text-book—namely, that he frequently introduces a new topic by a statement derived from classical cytological views, but made as if those views still retained their original force. Thus he quotes without comment (p. 170) Wilson's view that the structureless hyaloplasm is the most constant and active component of the cell, even though he is well aware of the extent to which this opinion requires modification in the light of the role of the mitochondria. Again, he repeats—and does so as if the generalization admitted of no exceptions—that "the living nucleus appears optically empty, both in normal light and dark-ground". If students are to be spared the necessity of leaping old hurdles, it is the limited value of the light-microscopic image which requires emphasis; and what is important is that the nucleus is *not* optically homogeneous when viewed by phase-contrast. The reason for such statements is the difficulty we all experience of escaping from the somewhat mystical concepts of classical cytology: the twin man-made ghosts, *the* nucleus and *the* cytoplasm, both homogeneous in the light-microscope—and by implication homogeneous in every other respect as well.

Not only in cytological matters, but also in the exposition of biochemical topics, Dr. Haas sometimes modifies his initial position profoundly and disconcertingly at a later stage. Thus, the discussion of molecular shapes (p. 28 *et seq.*) proceeds as if chain molecules of the linear polypeptide or polysaccharide type were the only type of linear macromolecules known. Not until the discussion of cytoplasmic structure (p. 194) do we learn of polymerization of globular molecules to form fibrils.

Dr. Haas writes a simple German style of somewhat unusually short sentences. Particularly successful sections are those on mitochondria, nucleus, cell-respiration, growth and differentiation. It is evident that considerations of cost have influenced both layout and the extreme economy of illustration. The latter is regrettable; for Dr. Haas's book, in spite of its title of 'cell physiology', is a 'cytology'. That is one indication of the distance travelled during the past twenty-five years; another is this, that the name of Boveri occurs but once, and without a reference.

Laurence Picken

LEARNING IN MAN AND ANIMALS

THE discussion on "Learning in Man and Animals" on May 16, initiated by the Section of Comparative Medicine of the Royal Society of Medicine, fell into two relatively clearly differentiated parts. One of these might be called naturalistic-empirical; concern here is with field-observations and the direct assessment of certain experimental modifications. Dr. W. H. Thorpe's discussion of "Key Problems in Animals" is characteristic of this approach.

Dealing with the problem of instinct in animal learning, Dr. Thorpe pointed out the value of studying the songs of birds in this connexion, particularly in view of technical advances made in recent years (he instanced tape recordings and electronic methods of analysis). Some birds apparently have their song patterns determined completely by heredity, so that the self-same patterns are produced even when they are brought up in complete isolation. Other birds, such as chaffinches, react to such 'Kaspar Hauser' experiments in rather a different manner. The song pattern resembles that of birds brought up normally, in its broadest outline, but lacks all the finer modulations and modifications. If such birds are brought up in groups, they do learn to modify the original pattern until, finally, all the birds in the group produce patterns which are virtually indistinguishable from each other. These patterns do not change even when later on the birds are exposed to song patterns of free animals, and thus 'group learning' may account for the well-known facts of local dialects in chaffinches. Chaffinches do not learn the songs of other birds like, for example, bullfinches, who will learn almost any kind of pattern quite easily.

Regarding the learning ability of animals and particularly birds, Dr. Thorpe mentioned the recent work of Otto Köhler in Austria, who has studied the counting ability of birds and squirrels. Much of the previous work in this connexion has been vitiated because of accidental clues, and this recent work is notable because of its experimental rigour. In one group of experiments, jackdaws were taught to open a box having on it a number of dots corresponding with a number of dots on a key card presented to the animal. Great care was taken to vary the positions of cards and boxes, to randomize the size, shape and position of the dots, and in fact to eliminate all possible clues except that of number. Under these conditions it was proved conclusively that birds can compare groups of units and act in accordance with this information. The limit of this ability appeared to be in the neighbourhood of six or seven. This is an interesting finding in view of the fact that in human beings also the process of number estimation shows a definite break roughly at this number. Below it human beings appear to employ a process of what has been called 'subitizing', which is characterized by immediate, errorless, apprehension of number. Apparently birds possess this ability to the same extent as man; what they do not apparently possess is the additional ability to count. Learning along these lines appears to be quite reliable and accurate in birds. The interesting point was raised that there appears to be no obvious biological function which this ability serves, as the birds cannot be assumed ever to use number estimation in their natural habitat.

Mr. B. B. Boycott's paper on "The Neural Basis of Learning in *Octopus vulgaris*" dealt mainly with the abilities of octopus to learn to discriminate between different stimuli, and the effects on memory of the removal of parts of the vertical lobe. Discrimination learning was established by associating rewards (crabs) with one figure, and electric shock with another. Apparently the animals have no difficulty in establishing differential responses to black as opposed to white, to large as opposed to small, and to differences of position. They tend to fail in shape differentiation, as, for example, in discriminating between a square and a diamond, or a square and a circle.

Memory was studied after the removal of various parts of the vertical lobe, an important aspect of the experiment being that operations were carried out both before and after the original learning had taken place. The results indicated that the proportion of brain tissue removed had an important effect on the decrease in efficiency of performance, very much as had been found by Lashley, many years ago, in the case of rats. The results are difficult to interpret, however, because the experimenters failed to differentiate between learning and performance, using the latter as an index of the former. That this is inadmissible was shown quite clearly in one of the experiments described, in which it was found that an octopus after operation apparently lost all power of discrimination when the positive and negative stimuli were presented with the bait actually on them, but showed almost perfect discrimination when the stimuli were presented without the bait. In fact, there appears to be a close similarity between leucotomized humans and brain-operated octopus in terms of greater impulsiveness and lessened inhibition. These temperamental effects of brain damage are important and might be worthy of closer study.

The next two papers dealt rather with theoretical models in terms of which results of learning experiments can be analysed. While also concerned with experiments, it should be noted that adherence to this approach implies a rather different attitude compared with the naturalistic field-study type of approach, which in its extreme form appears to study facts for their own sake. To the theoretical psychologist the experimental demonstration or the empirical fact is important in so far as it contributes to a theoretical formulation or decides between several deductions from different theories. At the present stage of research on learning, both types of approaches are of obvious interest and value and serve mutually to complement each other.

In his discussion of "What Do We Learn ?", Dr. H. Kay was concerned with putting forward a version of what is sometimes called the probabilistic theory of learning. According to this way of looking at the learning process, past experience establishes certain expectancies according to which an individual judges the most probable sequel of any given stimulus. Such a model has obvious relevance to conditioning experiments, and Dr. Kay demonstrated for many everyday situations that an explanation of learning

in terms of the dependent probabilities within a series of events can be made to appear reasonable. He extended this type of analysis to the learning of simple skills, showing how the learning of such simple acts as that of catching a ball can be interpreted in probabilistic terms.

The strength of such an approach lies in the ease with which quantitative analysis becomes possible; we can obviously measure probability of occurrence of a given act in terms of the relative frequency with which the act is in fact performed. The obvious weakness of the approach is two-fold. In the first place, the probability of an act changes with its performance, so that it is difficult to attribute any operational meaning to the probabilistic analysis in the case of the individual person. We can do so only in terms of groups of people, and it is doubtful to what extent the averaging of responses is permissible. It has been suggested that, as a general rule, averaging of response-rates is permissible only when the formula according to which growth takes place can be expanded by Taylor's theorem; this sets severe limits to this form of analysis. Another, and probably more fundamental, objection to this model is that it seems to leave psychology behind altogether by its complete failure to analyse the different components (drives, habits, etc.) which enter into the learning process.

As the last of the four papers, Prof. H. J. Eysenck's discussion of "Modern Learning Theory" presented a more orthodox type of model which has become widely accepted among psychologists. This model, which is due largely to the work of C. L. Hull, is a combination and formalization of two streams of thought, both of which are of considerable antiquity. One component is that of hedonism, or motivation by pain and pleasure; this was formalized and subjected to experimental study by Thorndike as the 'law of effect', and now emerges under the name of 'reinforcement' or 'drive reduction'. The other component is that of associationism; this was brought under experimental control by Pavlov and Beckterev, in the form of conditioning or habit formation. Hull joined these components in an impressive theoretical structure the formal character of which makes possible large numbers of experimental predictions, many of which have been verified. This approach, it should be stressed, is a purely molar one; the concepts are what psychologists call 'intervening variables' or 'hypothetical constructs' for which no neurological or physiological equivalent is necessarily postulated.

The most important concept in the theory is a dissociation of performance (symbolized by Hull as ${}_{S}E_{R}$) from habit (symbolized as ${}_{S}H_{R}$). Habit is conceived as a relatively permanent modification of the nervous system which mediates all learning; performance can only be used as an index of this modification under certain conditions. To equate the two, as is often done by experimenters lacking psychological sophistication, is to invite disaster. Much experimental work has been done on the conditions determining the growth of ${}_{S}H_{R}$, and among those found are: the number of reinforcements given, the nature and amount of the reinforcing agent, and the delay in reinforcement.

The fundamental formula linking performance and habit introduces the concept of drive which acts as a multiplicative variable according to the following formula:

$$ {}_{S}E_{R} = {}_{S}H_{R} \times D $$

Further concepts are necessary to make this formula applicable to the majority of experimental studies. In particular, we must add the concepts of reactive inhibition (I_R) and of conditioned inhibition (${}_{S}I_{R}$). According to the theory, all learning, that is, all formation of stimulus–response connexions, produces some degree of inhibition or fatigue in the mediating structures; this fatigue acts as a negative drive and tends to dissipate with time during periods of rest. Such dissipation acts as a reinforcement for the prevailing state of affairs, namely, the state of rest, so that we obtain a concept of conditioned inhibition which is essentially a negative habit, that is, a habit of not responding to the stimulus.

There is strong evidence to support this type of analysis, and the fact that many predictions can be made from the general theory, which can be experimentally verified, has led to its adoption by large numbers of students of the theory of learning. One such prediction was discussed in some detail, namely, that linking the predominance of inhibitory potential with extraverted and hysterical-psychopathic personality types, while linking the predominance of excitatory potential with introverted, anxious, depressive personality types. Experimental evidence from conditioning and other studies employed bears out this linkage.

METEOROLOGICAL RESEARCH AT PORTON

By Dr. F. PASQUILL

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FROM its beginnings in 1921, research in meteorology at Porton has been primarily concerned with the study of atmospheric diffusion, and the current programme of observations, which was formally incorporated in the research programme of the Meteorological Research Committee of the Air Ministry early in 1955, involves no departure from tradition in any fundamental sense. It does, however, contain new items which significantly reflect the broadening of interest from small-scale processes such as those involved in smoke screening, to larger-scale processes such as those which determine the dissemination of 'cloud-seeding' agents from generators operated on the ground.

In considering the new lines of investigation, it will be useful first to note briefly the position reached in the earlier work. Shortly after the end of the Second World War, the now well-known pre-war studies of eddy motion and diffusion in the atmosphere near the ground were consolidated and

extended, and it is especially noteworthy that by appealing ultimately to the experimentally established laws for the drag exerted by a rough surface on fluid motion over it, the *vertical* diffusion of airborne matter was quite accurately related to the observed vertical profile of wind speed over the particular surface. This important result has two limitations, first, in being restricted to the height-range over which the horizontal turbulent shearing stress may be assumed constant (usually taken to be of the order of 100 ft.), and secondly, in being applicable only in the absence of buoyancy effects, that is, in the absence of marked temperature gradients which so frequently occur vertically in the lower atmosphere. Some extension to these conditions was attempted on the basis of the observed diminution of the influence of buoyancy as the boundary is approached ; but the device has only been partially justified in unstable conditions and it appears not to be acceptable at all in stable conditions. No really satisfactory progress has recently been made in the case of *horizontal* diffusion, and for the time being reliance must continue to be placed on some form of analogy with vertical diffusion.

The point to be emphasized at the present stage is that, although it is not uncommon for the previous results to be extrapolated, there is nothing in the observations and the theoretical understanding which justifies this procedure beyond about 1,000 yd. in distance and 100 ft. in height. It is clear, therefore, that the first requirement imposed by the present extension of interest is for the accumulation of reliable observational data on the distribution of airborne material at distances of at least tens of miles from a known source. It is also necessary to examine the eddy structure which leads to this distribution ; and since experience quickly shows that in tens of miles material released at the ground may diffuse vertically to thousands of feet, this examination must accordingly be made at heights considerably greater than those usually adequate in micrometeorological investigations. These last few features determine the form of the new experimental studies which are at present being carried out at Porton by the Meteorological Office in conjunction with the Ministry of Supply.

Observations of the distribution of airborne material at 'medium' range from a point source are being made with the aid of a tracer technique originally developed in the United States. A fluorescent pigment, zinc cadmium sulphide, is dispensed into the atmosphere at a controlled rate of the order of 100 gm. per min., and samples of the particles, which are mainly in the size-range 1–5 microns in diameter, are afterwards collected by drawing air through an impactor which contains an adhesive receiving surface on a drum. This drum may be rotated by small amounts at predetermined intervals, so that over a period of time a large number of separate samples may be stored on a single drum. Under ultra-violet light, the particles fluoresce with a characteristic yellow-orange colour and so may be distinguished from naturally occurring fluorescent substances and counted with confidence. As 1 gm. of the pigment disperses into something like 10^{10} particles, it can be seen that the method is remarkably sensitive.

In practice, the impactor is carried across the plume of particles by an aircraft operating at various heights in succession, or by a motor-vehicle travelling along conveniently situated roads. In this way the distribution in a cross-wind section of the cloud is obtained at various distances. Preliminary experiments during the first part of 1955 provided encouraging experience in using the technique at distances up to 40 miles and heights up to 4,000 ft., and at the same time gave a useful rough indication of the distributions to be expected in point-source clouds in certain conditions. The plan is now to conduct the experiments systematically in a number of well-defined synoptic conditions. The experiments are quite difficult operationally, requiring to start with a coincidence of predictable suitable weather conditions and the availability of an aircraft. They also bring new technical problems, such as the quantitative sampling of an aerosol cloud at the high speed of an aircraft and—a problem now receiving attention—the collection of samples in the presence of a cloud of water droplets, when the usual impactor technique becomes unsuitable. Also it is clear that the diffusive properties which are being examined exhibit a great degree of inhomogeneity, and can be described adequately only in a statistical sense from a large number of experiments. For such reasons the progress in this investigation will probably be slow.

The study of eddy structure and its effect on diffusion may be made along two lines : first in terms of the eddy velocities and their variation in space and time, and secondly in terms of the statistical behaviour of identifiable particles which may be assumed to follow the local air movement. The second line is, of course, being followed in the tracer experiments just referred to ; but it is exploited there only in a broad fashion, and the resulting knowledge of the final distribution in a field of turbulence which frequently varies in space and time may itself be of limited value. It seems most necessary to support these observations with more penetrating experiments on the diffusion of particles ; and for the design of these experiments and the provision of a framework to hold the results the most encouraging prospect seems to be offered by the statistical theories of turbulence. These theories recognize two ways of describing the diffusive motion of particles, one referring to the statistical displacement of a single particle with respect to its origin, and the other to the separation of a pair of particles with respect to some initial separation. There are important fundamental issues involved in distinguishing between these two systems of description ; but the choice is usually affected to some extent by convenience in interpreting the observations in a practical sense and to a large extent by the feasibility of the experiments which would be appropriate. On these grounds choice has initially fallen on the former system, though experiments involving the latter system are now under consideration.

A good deal may be gained by designing the experiments on dispersion of particles for sites well above the surface, for then not only is attention directly paid to the higher levels, which must control diffusion ultimately, but also the avoidance of the marked shear in the airflow near the surface should ensure a simpler form of diffusion more amenable to treatment by theories which for tractability require the assumption of steady homogeneous turbulence. The present experiments have accordingly been planned to use dispensing and collecting equipment carried on the cables of tethered balloons, and for obvious reasons vertical diffusion rather than horizontal is investigated. Unfortunately, the conventional filtering or impacting equipment normally

used for collecting particles is far too elaborate and heavy for extensive use in this fashion. This difficulty has been overcome by merely allowing the particles to impact naturally on adhesive cylinders held into the wind by light vanes spaced out along the balloon cable. Spores of *Lycopodium* are used as these are big enough (30 micron diameter) to impact with reasonable efficiency (near 50 per cent in normal wind speeds for a cylinder of diameter 0·25 in.), relatively easy to recognize and count under a microscope of moderate magnification, and yet possess a free falling velocity (2 cm./sec.) which will normally be much less than one-tenth of the vertical eddy velocities.

A first series of experiments has been carried out using the above technique, the particles being released for half an hour at a time at a height of 500 ft. and sampled at distances of a few hundred yards downwind. At the same time the fluctuating inclination of the wind at the position of release of the particles was measured by a light responsive vane, the movements of which were recorded electrically at ground-level. This instrument was designed especially for use on a balloon cable and includes automatic compensation for the varying inclination of the cable. The few results analysed so far indicate that even after a travel of 500 metres, the vertical distribution of particles may still be very closely in accordance with the distribution of the inclination of the wind. This implies the existence of a Lagrangian type of correlation, that is, one which is concerned with the velocities of the same sample of air at successive intervals of time, with a coefficient maintained close to unity for as long as one minute or more. On the other hand, from the 'instantaneous' values of wind inclination, it was found that the Eulerian correlation coefficient, namely, that between the inclination at a fixed point at a given time and the inclination at the same point some time later, had fallen to near zero in about 10 sec. This much greater persistence of velocity in a Lagrangian than in a Eulerian sense is a known feature of wind-tunnel turbulence, and evidence is now accumulating for a similar feature in atmospheric turbulence. If it is confirmed, this would mean that the convenient substitution of the measurable Eulerian coefficient for the almost unmeasurable Lagrangian coefficient is unacceptable even as a rough approximation. However, experiments of the present type may then reveal systematic connexions between the Lagrangian and Eulerian characteristics, as in fact has already been done in wind-tunnel experiments, and so provide some real physical insight into the fundamental features of atmospheric diffusion.

In addition to studying the relation between diffusion and the measurable aspects of eddy structure, it will also be important to have a more general description of the space-time variations of eddy structure than is available from the conventional micrometeorological investigations near the surface. The instrument for measuring the fluctuations of wind inclination from a mounting on a balloon cable has already been operated with some success at heights up to 5,000 ft. and has provided some interesting indications of the variations of turbulence with height and time. Plans are now in hand to increase the instrumental equipment and to use it more extensively. Such measurements should provide further knowledge of the nature, growth and decay of mechanical turbulence and convective motion over a substantial depth of the troposphere.

REVISION OF THE POLICY ON BREAD IN GREAT BRITAIN

TOWARDS the end of the Second World War, consideration was given in Britain to the desirability of specifying the type of flour to be used for bread-making once the period of war-time restrictions was over. The Conference on the Post-War Loaf[1] recommended that an 80 per cent extraction-level should be the minimum permitted and that more refined flours enriched with two or three nutrients should not be considered equally acceptable. A report by the panel on Composition and Nutritive Value of Flour has now been published* which, while agreeing that a plain flour of less than 80 per cent extraction would constitute a nutritional hazard, nevertheless concludes that the addition of thiamine, nicotinic acid and iron would provide sufficient safeguard. This is the point of view favoured by the millers, and it was chiefly pressure from them that caused the present Panel to be set up.

When, in 1953, the Government found it possible to relax controls on cereals, the trade obtained permission to prepare flour of 70 per cent extraction provided thiamine, nicotinic acid and iron were added to it; but such flour did not qualify for subsidy when used in bread-making. To the surprise of the millers, the public showed remarkably little interest in this new flour, and sales of bread made from it never reached a higher proportion than 4·4 per cent of total bread sales; by the middle of 1955 this proportion had dropped to 0·8 per cent. The millers claim that the public really prefers such bread but cannot afford to buy it. It would seem equally arguable that people were quite satisfied with the National loaf.

In pressing for permission to mill a low-extraction flour, the millers also sought (and obtained) permission to make up National flour by blending as well as by the straight-run process. This completely undermined the safeguards which the Conference on the Post-War Loaf sought to provide, and the value of National flour steadily deteriorated. The present report refers to "the acknowledged infringement of the spirit of the Flour Order" and states that "The Panel believes that the immediate drop in the vitamin B_1 and nicotinic acid content of National flour after decontrol and the continuing fall since, have resulted primarily from deliberate disregard of the intention of the Flour Order rather than from such factors as variations in the character of the wheat from which the flour was milled, although these factors may have played a secondary role". The report argues that a policy of adding specified nutrients would give greater assurance of their presence, since "if the miller is free to sell enriched white flour of any technical quality which he desired

* Report of the Panel on Composition and Nutritive Value of Flour. Pp. vii+34. (Cmd. 9757.) (London: H.M.S.O.) 1*s.* 6*d.* net.

Table 1. NUTRIENTS PRESENT IN WHEAT FLOUR (REPRESENTATIVE VALUES)

Nutrients (per 100 gm. flour)	Wholemeal	Flour of 70 per cent extraction
Proteins (gm.)	12·2	11·0
Fat (gm.)	2·3	1·1
Calcium (mgm.)	45	18
Potassium (mgm.)	376	144
Magnesium (mgm.)	127	24
Phosphorus (mgm.)	287	102
Sulphur (mgm.)	165	108
Chlorine (mgm.)	62	53
Iron (mgm.)	4·2	0·8
Copper (mgm.)	0·8	0·2
Manganese (mgm.)	4·5	0·4
Tocopherol (μgm.)	910	30
Thiamine (μgm.)	500	70
Riboflavin (μgm.)	100	35
Pyridoxine (μgm.)	460	220
Choline (mgm.)	90	50
Folic acid (μgm.)	50	12
Biotin (μgm.)	8	0·5
Nicotinic acid (mgm.)	7	1·2
Pantothenic acid (mgm.)	1·3	0·6

A full set of values is not available for flour of 80 per cent extraction, but in general the higher the extraction-rate the greater the retention

there would not appear to be much temptation to add less than the specified quantities of nutrients".

The recommendations of the Conference on the Post-War Loaf, however, were intended to safeguard health by assuring that the flour used for bread-making contained not only thiamine, nicotinic acid and iron, but also a fair measure of the numerous other nutrients which wheat can supply. Since exact requirements for many of these other nutrients have not yet been established, it cannot be said for certain that the differences between 80 per cent flour and enriched 70 per cent would prove of nutritional significance, but equally it cannot be said that they would not. The matter still awaits investigation (the so-called 70 per cent extraction flour used in the much discussed Widdowson and McCance experiments[2] contained thiamine, riboflavin and nicotinic acid in quantities greater than is usual at that level and must be assumed to have provided more of the remaining nutrients also). Table 1 sets out some of the nutrients which are present in wheat and shows what a severe reduction occurs in milling to a 70 per cent extraction level. Only a few of these nutrients were given consideration by the Panel, yet the others may be of equal—or even greater—importance.

In this report the Panel gives the warning that "The history of nutrition reveals many instances where the refinement or over-purification of food has led to ill-health and there is no reason to believe that this chapter of knowledge is closed". The Panel, however, seems to assume that the National Food Survey would give adequate warning of any need for further revision of bread policy. But research workers already feel[3] that over-sophistication of food may provide the explanation of many of the diseases which beset 'civilized' man despite his extensive medical services, and the present time seems inauspicious for a reduction of the dietary supply of some fifteen or more minor nutrients merely to suit trade interests. Moreover, the proposed change would require nearly a quarter of a million extra tons of wheat a year.

M. W. GRANT

[1] Rep. Conf. Post-War Loaf. (Cmd. 6701.) (London: H.M.S.O., 1945.)
[2] Widdowson, E. M., and McCance, R. A., Med. Res. Counc. Spec. Rep., Ser. 287. (London: H.M.S.O., 1954.)
[3] Platt, B. S., *Brit. Med. J.*, i, 179 (1955). Sinclair, H. M., *Lancet*, i, 381 (1956).

NATIONAL PHYSICAL LABORATORY

OPEN DAY

'OPEN Day' at the National Physical Laboratory, Teddington, serves a dual function: it gives representatives of industry, universities, government departments and the technical and daily Press an insight into the work of one of the largest national research laboratories in Britain and, no less useful, serves to indicate the direction of national research effort in many branches of science and engineering. About three thousand visitors attended this year and 225 exhibits were on view. During the afternoon, the General Board of the Laboratory met to consider the Executive Committee's annual report[1].

The Metallurgy Division celebrates this year its fiftieth anniversary, and it was appropriate that its exhibits provided evidence of its continued interest in the constitution and structure of metals and alloys in relation to their physical and mechanical properties, work for which the Division has gained an international reputation. An investigation of the constitution of a uranium–palladium system undertaken for the Atomic Energy Research Establishment revealed the interesting feature of a considerable solid solubility of uranium in palladium; since the electronic structure of palladium is known, measurement of certain physical properties such as electrical resistivity, paramagnetic susceptibility, thermoelectric power and lattice parameter suggested that uranium dissolves in dilute solution with an effective valency of 6, but at higher concentrations the valency is probably 4.

The study of high-purity iron with particular reference to elucidating the embrittling effect of traces of impurities in amounts as low as 0·001 per cent has led to the development of an electrolytic process with the view of producing sulphur-free iron; a commercial cation exchange membrane was used for dividing the electrolytic cell and preventing the transfer of the sulphur-containing anions. Tensile tests on single crystals of iron at −196° C. indicated that orientation had a marked effect on brittle fracture[2], and further investigations of rolled Swedish iron bar using the National Physical Laboratory X-ray diffractometer confirmed that texture had a marked effect on brittle properties. The tracer laboratory is now in full operation, and equipment has been designed to measure the rate of diffusion of antimony in copper, and to study the self-diffusion of silver under fatigue stress.

The steadily increasing use of radioactive materials has necessitated a simplified calibration procedure for checking their activities. For this purpose and to ease the demand on standard samples of radioactive substances, the National Physical Laboratory's Advisory Committee on Radioactive Standards and

the Atomic Energy Research Establishment, Harwell, have jointly arranged for the commercial production of a combined beta–gamma ionization chamber for the measurement of β-ray and γ-ray sources in the range 1 microcurie to a few millicuries. This equipment was shown in the Physics Division, which also demonstrated the principle of a possible alternative to the fundamental method of determining temperature by the so-called 'gas thermometer'. In this case use was made of the fact that the spontaneous fluctuations in voltage in a metallic conductor, or 'Johnson noise', have a statistical variance which is proportional to the absolute temperature; modern electronic amplifiers have made it possible to measure with the required precision the electrical energy generated, which at the melting point of gold is about a hundred-millionth of a microwatt. Such a method will be useful in permitting the absolute measurement of temperature in circumstances where a gas thermometer could not be used.

Work in the field of high-pressure physics includes the establishment of standards for the measurement of high pressures up to 3,000 atmospheres and beyond. The new National Physical Laboratory 'similarity' method for the precise calibration of pressure balances[3] was demonstrated and indicated how the hitherto limiting factor of accuracy, namely, the difficulty of measuring the effective area of piston–cylinder assemblies due to distortion, was overcome by using two assemblies of the same dimension but made in materials (hard tool steel and high tensile bronze) having different elastic constants. This Division also showed the results of tests and equipment used for determining the effective biaxial mean stress on fatigue failure, a problem of considerable importance in aircraft design; the biaxial stressing is obtained by applying gas or oil pressure to a hollow test-piece, and the results confirmed that the energy needed to propagate fast fracture is that resident in the compressed gas. Among other interesting exhibits was an ultrasonic viscometer using the National Physical Laboratory split-tube type of barium titanate torsional transducer which, in a high-intensity form, can be made capable of measuring the effects of large particles in hydrosols; and new equipment for investigating thermal and electrical conductivities to well above 1,000° C.

A notable event in the standards field was the completion in the Electricity Division of a cæsium atomic beam standard of frequency and time interval. The cæsium beam chamber on view incorporated a number of changes suggested by investigations of its performance during the past eight months[4]. The present experimental model provides a unit of time which is accurate to $\pm$ 3 in 10^{10} (one-hundredth of a second in one year). By comparison with this primary reference standard, quartz clocks, still the most convenient working standard, can now be calibrated over a period less than one second with a precision of one part in 10^9. This improved accuracy in calibration will be made generally available by the *MSF* standard frequency transmissions which are continuously monitored at the Laboratory.

In the High-Voltage Laboratory of this Division equipment is being set up to investigate the breakdown strength of a wide range of organic liquid dielectrics. It will allow the measurement at atmospheric or reduced pressure, at ambient or higher temperatures, after fractional distillation, fine filtration, drying and degassing, or any combination of these; the effect of the shape and duration of the voltage wave, as well as electrode material, will also be investigated. At the rear of this building a new million-volt 700-kVA. oil-immersed transformer is being installed to replace the bank of air-insulated transformers which have given useful service over the past thirty years. Supporting towers and rain-spray equipment will also be provided for outdoor power-frequency tests.

A number of exhibits indicated the valuable assistance that the Divisions can give to each other in the course of their work. A good example is the new techniques used by the Metrology Division in the preparation of fused quartz cylinders for the construction in the Electricity Division of a new primary standard of inductance, from which the ohm is derived. With the aid of special lapping blocks, the variations in effective diameter of the helix have been reduced from 15μ to 5μ.

The Metrology Division also showed, in its final form, a microwave interferometer, the only equipment of its kind in existence, for the precise determination of the free-space vacuum velocity of electromagnetic waves. The fairly recent introduction of the geodimeter, which uses the speed of light for measuring distances of the order of 10 km., emphasizes the need for a value accurate to at least one part in a million. This interferometer uses two opposing microwave transmitters fed from a common source and, between them, a movable carriage supporting two receiving apertures, each facing a transmitter. The received signals are mixed to produce interference, and an accurately measured bar, two metres long, is used for determining the displacement corresponding to about 1,000 half-waves with great precision; the operating frequency is high (72 kMc./s.), and is measured by comparison with high harmonics of a quartz-crystal frequency standard.

The close contact which this Division maintains with industry was evident in the two methods demonstrated for measuring the camber of large rolls, one using an autocollimator and the other an interferometric technique. A number of exhibits, demonstrating the application of pneumatic gauging, were of special interest. The thickness of thin sheet material was shown being measured continuously by this method as it passed over a roller beneath a number of air jets. This apparatus, as at present designed, will measure to a lower thickness limit of 0·002 in. and an accuracy of $\pm$ 1 per cent. By means of a selector switch, variation in thickness of the sheet beneath any one of the jets can be continuously plotted by a pen recorder. A similar technique was demonstrated for testing the flatness of unexposed photographic plates.

Two thin-film type bolometers are being developed in the Light Division to meet the industrial need for sensitive non-selective detectors of infra-red radiation. Thin films of gold or antimony, less than two-millionths of an inch thick, supported on a plastic pellicle, are used. The blackened gold film bolometer is quite as effective as the best thermal detectors at present available and is robust enough for monochromators used in chemical process control; the amorphous antimony bolometer also shows promise in that it is highly sensitive to voltage and has an impedance so large that it can be connected directly to a valve amplifier, thus saving the expense of a step-up transformer.

Among other interesting exhibits in this Division were a photo-electric polarimeter which was con-

structed to investigate inaccuracies in the calibration of quartz plates used as standards of optical rotation; and a gas refractometer developed for testing trichloroethylene inhalers, with which the concentration of trichloroethylene in air is determined by comparing the refractive index of the vapour mixture with that of air in a Jamin-type interferometer. New methods have been developed for producing replica diffraction gratings in plastic; they make it possible to join several lengths to form continuous accurate gratings several feet in length. It was shown how these gratings can be used for the accurate measurement of movement or displacement by counting the moiré fringes produced when a short index grating is moved over a length of fixed grating of the same pitch. The possibilities of this technique of indicating position is being actively investigated and has been adopted in one instance for the automatic control of machine tools.

Work on the design of electronic digital computers continues in the Control Mechanisms and Electronics Division, which exhibited units of the new Automatic Computing Engine (ACE), that was seen in the process of construction. This will be a more powerful tool than its predecessors, the ACE Pilot Model and its engineered version DEUCE, as made by the English Electric Co., Ltd. The new computer will have a larger storage capacity or 'memory' and have an overall speed four times greater than DEUCE; in a typical working day it will average 20,000 'three address' operations per second and its mercury delay lines and magnetic drums will store a total of $1\frac{1}{2}$ million binary digits. With its other special facilities this machine will allow the solution of very complex problems which have hitherto not been possible with existing computers. A simplified flow diagram for wage accounting directed attention to the possible use of a high-speed computer, with magnetic tape equipment, in office work. This was based on the work done for a study group formed in 1954, consisting of representatives of the Organization and Methods Division of the Treasury, the Ministry of Pensions and National Insurance and the National Physical Laboratory, the first report of which has just been published[5]. This Division is also concentrating on the design of data-processing equipment and exhibited an automatic graph-plotter which enables information in punched card form to be plotted automatically at a rate of one point every two seconds for points lying fairly close together. Information is read from the cards serially and supplied through a relay distributor to the relay stores, the outputs of which are voltages proportional to the number held; these voltages are then supplied to the plotting table, which traverses the carriage to the corresponding point, and the plotting head is operated.

The Mathematics Division is now using DEUCE for solving large-scale numerical calculations arising in scientific research and industrial design. This machine was seen in operation and is being used for solving problems in mathematical physics, linear algebra, ballistics and aircraft flutter.

The facilities of the Ship Division are being extended, and a model was shown of the new Ship Hydrodynamics Laboratory now being built at Feltham, Middlesex. This will provide a ship model-testing tank 1,300 ft. in length, 45 ft. wide and 25 ft. deep, and its carriage will have a maximum speed of 50 ft. per sec. There will also be a new water tunnel 40 in. in diameter for research on propellers; work on 'cavitation' will be facilitated by a resorber circuit which will go 200 ft. below ground-level. A problem associated with the arrangement for supporting and driving the propeller model in this new water tunnel was demonstrated. A mechanical model indicated the method of investigating the different modes of whirling of an overhung shaft and the effects of alteration in the shafting or bearings at critical whirling speeds, with the view of determining the best supporting system. In the Yarrow Tank a lightship was seen undergoing tests in rough water. These experiments are on behalf of the Corporation of Trinity House and the Commissioners of the Port of Calcutta, and are being made under conditions simulating the effect of tide, wind and waves on the riding behaviour of an anchored lightship. The high cable tensions are affected by the hull form, and methods of reducing the cable tension have been suggested.

Of special interest to visitors to the Aerodynamics Division were the wind tunnel exhibits demonstrating methods for improving the efficiency of lifting surfaces by preventing flow separation. Such studies are of vital importance for improving the landing and take-off performance of high-speed civil and military aircraft, where the trend towards highly swept wing-forms has necessitated relatively high landing and take-off speeds. High lift was demonstrated in the 13 ft. × 9 ft. wind tunnel by blowing high-velocity air over a trailing-edge flap of a half-model delta wing to re-energize the boundary layer. In the 9 ft. × 7 ft. wind tunnel experiments were in progress to ascertain the usefulness of boundary-layer control at the wing nose when combined with jet flaps at the wing trailing-edge.

In high-speed flight, shock-induced boundary layer separation from a wing or other component of an aircraft seriously affects stability and control of the aircraft. This formed the subject of a film, in colour, which was shown to visitors. An interesting exhibit concerned experiments on a thin half-aerofoil section designed to be free from boundary-layer separation for an appreciable range of lift coefficients at all speeds, thus enabling the formation of a shock wave to be studied independently of boundary-layer interaction and a check to be made on theoretical results. The influence of the shape of the leading edge on change in the type of separation that occurs as the Mach number is raised for a wing at high incidence was also being studied.

Equipment specially designed for the measurement of aerodynamic forces on oscillating wings was exhibited in this Division. It is intended to provide fundamental data relating to oscillating forces at high speeds and frequencies, and will be used for checking the theoretical methods at present used when designing aircraft to guard against oscillatory instability in flight. An electro-mechanical feed-back system is used, incorporating a torsion bar linking two inertias, one carrying the model and a displacement pickup, and the other being electromagnetically excited at its natural frequency.

The Laboratory's testing facilities are constantly being extended to meet new demands. Three new water-baths have been installed in the Test House to facilitate testing and avoid fatigue of observers testing clinical thermometers, of which more than half a million were tested last year. With the increasing use of viscometers in various industrial applications, and by the oil industry in particular, there has been an increasing demand for the calibration of a range and variety of these instruments;

temperature control has been installed in rooms used for this work. The testing of trichloroethylene inhalers intended for use by registered midwives has been facilitated by the use of the new gas refractometer referred to previously. Two prototypes have been approved, and about 110 inhalers have been tested. 'Trouble-shooting', the theme of an interesting exhibit, stressed the assistance given by the Test House to enable manufacturers to overcome their production difficulties and to improve the quality and accuracy of their output. E. I. Brimelow

[1] National Physical Laboratory. Report for the Year 1955 (London: H.M.S.O., 1956).
[2] Allen, N. P., Hopkins, B. E., and McLennan, J. E., *Proc. Roy. Soc.*, A, **234**, 221 (1956).
[3] Dadson, R. S., *Nature*, **176**, 188 (1955).
[4] Essen, L., and Parry, J. V. L., *Nature*, **177**, 744 (1956).
[5] "Wage Accounting by Electronic Computer" (London: H.M.S.O., 1956).

OBITUARIES

Prof. Carl Ramsauer

Carl Ramsauer, who died in Berlin on December 24, 1955, was an outstanding character as well as an outstanding physicist. As a young man, he made his way by his toughness and purpose. Born on February 6, 1879, in Osterburg, a little place in Oldenburg where his father was the Lutheran parson, in his early twenties he occupied a diversity of positions, including those of schoolmaster and assistant in the torpedo laboratory at Kiel, at which University he took his doctorate with an interesting and original thesis on the mechanism of ricochet from water. He was twenty-eight when Lenard, who had been professor at Kiel, enabled him to take up an academic career by appointing him to a post in the Physics Institute at Heidelberg. Here he worked, except for the war period, during which he was an artillery officer, until 1921, when he was appointed professor of physics at the Technische Hochschule at Danzig. With Lenard he carried out a series of significant researches on the ionization produced by ultra-violet light; but the work that brought his name into prominence was his discovery, in 1921, that slow electrons pass much more easily than swifter ones through the atoms of the rare gases, the so-called Ramsauer effect. In this connexion he introduced the term Wirkungsquerschnitt (effective cross-section), which has been so widely used.

At Danzig, Ramsauer proceeded to transform the small and comparatively unimportant department into a first-class institute for teaching and research in physics. He was by inclination and training an outstanding teacher, taking the greatest pains and pleasure to devise effective lecture experiments and to make clear the fundamentals of the subject. The research school, which was occupied mainly, but by no means exclusively, with the passage of electrons through matter, was known for the precision and clarity of its work. By 1928 his reputation was such that when the Allgemeine Elektricitätsgesellschaft decided to found a research institute, Ramsauer was appointed to direct it. His gifts as an organizer and controller of research found full expression in this extremely responsible post. Under him work proceeded not only in physical, but also in chemical, electrotechnical, metallurgical and other departments of the great institute. He installed 'technical-physical workshops', which were of great value. He continued his personal research on effective atomic and molecular cross-sections, and the work which he carried out with Kollath on the scattering of protons is classical. In 1931 he became joint editor of the *Zeitschrift für technische Physik*, and many other responsibilities of this nature accrued to him.

During the Second World War, Ramsauer was elected president of the Deutsche Physikalische Gesellschaft, a very difficult position at that time. With characteristic courage he spoke out against the many abuses and shameful personalities which were ruining German physics, his letter, sent in 1942, to Rust, then Minister for Education, being particularly uncompromising. It had no result; but if Ramsauer had been a less valuable and less respected man it might have been fatal for him.

After the War, Ramsauer occupied himself with reorganizing the teaching of physics at the Technische Hochschule at Charlottenburg, a task for which his gifts and experience particularly fitted him. In 1953 he published a remarkable little book dealing with the history of certain fundamental experiments in physics. He did not give up his post until he reached the age of seventy-five, and died shortly after his resignation.

Ramsauer was a quite exceptional personality. He disliked any parade of sentiment, but he was a staunch friend and a man of firm principles, who never truckled to those in power. He was a most entertaining talker, with a strong and sometimes biting sense of humour, to which he gave epigrammatic expression. For example, of a certain somewhat undistinguished physicist who had a double name—let us call him Wolf-Braun—he said, "Gauss-Weber were two men, Mittag-Leffler was one man, Wolf-Braun was nobody". He had a close acquaintance with German university folk-lore, including the legends of Bonifacius Kiesewetter, and a great knowledge of German literature in general, including many byways. He will long be remembered by all who had to do with him, and especially by the few still living who knew him at Heidelberg.

E. N. da C. Andrade

Sir John Stirling-Maxwell, Bart., K.T.

Sir John Stirling-Maxwell died on May 30 at the age of eighty-nine at his home, Pollok House, famous for its lovely gardens, near Glasgow. He succeeded his father at the age of eleven, and went to Eton and then on to Trinity College, Cambridge. He was Conservative member of Parliament for the College Division of Glasgow between 1895 and 1906, when he lost the seat. It was then that he gave his time to his real hobby. Sir John may be termed one of the early modern pioneers of forestry, then called arboriculture in Scotland and England, in the latter part of the past century and the early years of the present. He studied the subject intensively in many European countries and made use of the knowledge so acquired on his own estate, and was always ready with advice or suggestions to friends.

In his own practice, after failures to establish sitka spruce plantations on his estate at Corrour, and his

greatly loved lodge there, by the usual methods of level surface planting on peat soils, he introduced the method he had seen in Belgium of mound planting, in which the plants are placed in holes in the turves cut out in making the drains. He had immediate success at Corrour; and when, a few years later, the Forestry Commission began its work in the country, it followed Sir John on peat soils, afterwards greatly elaborating other methods. Sir John, whose whole heart was in forestry, was one of the first Commissioners, and his appointment as chairman of the Forestry Commission in 1929 was warmly hailed by foresters and all who knew of his work and his enthusiasm, and his departure at the end of his term of office at the end of 1932 was equally regretted. His quiet geniality, understanding and common sense were greatly appreciated and loved.

Sir John's life was devoted to public service. He had a great affection for art and acted in many public positions in this respect: as trustee of the Royal Fine Art Commission for Scotland, chairman of the Ancient Monuments Board of Scotland and as a trustee of the Scots National Galleries. He was an original member of the Board of Trustees of the Wallace Collections appointed to administer the bequest in 1897, and he served continuously on the Board, being its chairman for the past twenty-five years.

Sir John did a great deal to encourage the beginnings of forestry in Great Britain, and his name will remain enshrined in the annals of forestry.

E. P. Stebbing

NEWS and VIEWS

Experimental Philosophy at Oxford: The Right Hon. Viscount Cherwell, P.C., C.H., F.R.S.

For a man who shuns publicity, Lord Cherwell has been much in the news lately. In the recent Birthday Honours List he was made a Viscount and very shortly afterwards he announced his impending resignation from the Dr. Lee's chair of experimental philosophy at Oxford. F. A. Lindemann (now Viscount Cherwell) was educated in England and Germany and took his Ph.D. degree under Nernst at the University of Berlin in 1913. During his period in Germany he published, in conjunction with Nernst, a series of papers on "Studies of Specific Heats at Low Temperatures", and also proposed modifications in the Planck–Einstein formula for specific heats of solids based on the quantum theory and extended it to gases. Later, he published a book entitled "The Physical Significance of the Quantum Theory". During the First World War, Lindemann served as an experimental pilot and research scientist at the Royal Aircraft Establishment, Farnborough. It was during this period that he played a very large part in the successful solution of the spinning aircraft problem. In 1919, Lindemann was appointed professor of experimental philosophy at Oxford, so that he has held this chair for thirty-seven years. During this period he has built up the Clarendon Laboratory and initiated many important researches to such effect that to-day the Clarendon Laboratory is among the best equipped and staffed laboratories in the world for both low temperature and nuclear research work.

In pre-war years Lindemann formed a very firm friendship with Winston Churchill, and when at the outbreak of the War the latter was appointed First Lord of the Admiralty, Lindemann joined him in the capacity of personal scientific adviser. Later, when Churchill became Prime Minister, he moved with him to Downing Street. He was raised to the Peerage as Lord Cherwell in 1941 and in 1942 became Paymaster General and a member of the Cabinet. His duties were primarily scientific and statistical, and he was charged with the responsibility of keeping the Prime Minister acquainted with all the scientific problems and developments which affected the war effort. This he did largely by the use of his characteristically simple but illuminating methods of presenting information. In addition to this, he also accompanied the Prime Minister to the historic Quebec and Potsdam Conferences. Cherwell again became Paymaster General in 1951 and served in a similar capacity. His particular interests at this period were in the atomic energy field, and he was one of the main protagonists of the plan afterwards adopted for the removal of the Atomic Energy programme from the Civil Service. After his return to Oxford in 1953 he continued to serve as a member of the new Atomic Energy Authority. Cherwell is a man of strong opinions which he has not hesitated to advance. Many people have disagreed with him, but few will deny that he has had an important influence on our time.

Sir Francis Simon, C.B.E., F.R.S.

Sir Francis Simon, professor of thermodynamics in the University, has been appointed to succeed Viscount Cherwell. The Clarendon Laboratory will thus have as its new head a man who has a world-wide reputation for his achievements in all branches of low-temperature physics. Sir Francis, like Lord Cherwell, began his scientific career under Nernst, and it is not surprising that much of his earlier work was connected with the Nernst heat theorem. Indeed, the fact that this theorem is now generally recognized as the third fundamental law of thermodynamics is largely due to his work. During this period in Germany he also devised the small-scale cryogenic techniques, in particular the expansion method for liquefying helium, which made it possible to conduct low-temperature work even in laboratories with only quite modest facilities. On leaving Germany in 1933, he went to the Clarendon Laboratory at the invitation of Prof. Lindemann and became reader and later professor of thermodynamics. Under him the low-temperature department of the Clarendon Laboratory has grown to be one of the leading cryogenic laboratories of the world. His many interests have included the properties of liquid helium, magnetic cooling, low-temperature specific heats (in particular, the study of internal transitions), nuclear orientation, thermal conductivities and the properties of solids and fluids at high pressures and low temperatures. During the War, Prof. Simon played an important part in the British Atomic Energy project. He was one of the first to see the feasibility of a diffusion plant for the separation of the uranium isotopes on an industrial scale and he had a large group working under him on this project. Since the War he has also turned his attention to many questions of scientific policy, and

he is well known for his views on fuel policy, on scientific and technological education, and on the correct use of scientific man-power.

Chemistry at Birmingham : Prof. M. Stacey, F.R.S.

Prof. M. Stacey, who succeeds Prof. H. W. Melville (see *Nature* of February 11, p. 260) at the end of the present academic year as Mason professor of chemistry in the University of Birmingham, is the most outstanding Birmingham graduate of his time. He graduated under the late Sir Norman Haworth and continued, with short breaks in London and in the United States, at Birmingham as research student, lecturer, reader, until in 1946 a special chair was created for him to give him further scope for all his activities. Since that time he has expanded enormously the organic work at Birmingham. For many years under Haworth, Birmingham was the centre for carbohydrate chemistry in Great Britain, and the great advances made in this period laid the foundations of much of the subsequent developments into wider fields. Stacey's work was interrupted by the Second World War; but under the auspices of the Tube Alloys' project in Britain, he became interested in the chemistry of uranium and also of fluorine. This gave him the opportunity to enter the field of the organic chemistry of fluorine compounds and this part of his activities has flourished just as much as the carbohydrate field; at various academic institutions in Britain he has developed unique methods of dealing with the synthesis of a great variety of fluorine compounds and in seeking new uses for them in every possible way. Under Stacey's leadership, organic chemistry has increasingly widened its scope in Birmingham, with emphasis, too, on the biological implications of these developments of organic chemistry. In all these developments full use has been made of the more specialized techniques that have been available in the laboratory, especially on the physical side. These have made progress possible which was undreamt of in pre-war years. With greater responsibilities, the Chemistry Department under Stacey's guidance will, without doubt, develop actively and broadly in the years to come.

Italian Honours for Sir Cyril Hinshelwood and Prof. E. B. Chain

On June 5, the Italian Foreign Minister honoured two British men of science, Sir Cyril Hinshelwood, president of the Royal Society, and Prof. E. B. Chain, by bestowing on them the order of the Grande Ufficiale al Merito della Repubblica, one of the highest civil distinctions in Italy. Sir Cyril Hinshelwood has been a frequent visitor to Italy, and his work and personality are greatly appreciated in this country, the language of which he has mastered with perfection. He has done much to strengthen the ties between British and Italian scientists. Prof. Chain, formerly of the University of Oxford, has worked since 1949 in Rome, where he has built up a large and very active department for biochemical research at the Istituto Superiore di Sanitá, the chief centre for medical research in Italy.

Expansion of Metallurgy at Oxford

At a meeting of Congregation on June 12, a statute was promulgated which added the science of metals to the list of subjects that may be offered at Oxford in the Honour School of Natural Science. This subject covers much of the ground that is covered by those who offer chemistry in that Honour School. The amount of organic chemistry, however, has been reduced in order to provide room for the science of metals. The new course is divided into Parts I and II on the same lines as the chemistry course, and in Part II a candidate will submit a thesis on a metallurgical subject after spending a year on research. Classified honours will be awarded on the combined results of both parts.

The new course marks a further stage in the development of metallurgy at Oxford which follows the establishment of the George Kelley readership by the Pressed Steel Co. and the appeal for funds for the subject which was strongly supported by the late chairman of the Company, Major Albert Pam. Post-graduate research work in metallurgy has been carried out at Oxford for more than thirty years under Dr. W. Hume-Rothery in the Inorganic Chemistry Laboratory, where its development owes much to the interest of Sir Cyril Hinshelwood. An independent Department of Metallurgy under Dr. Hume-Rothery is now being set up in temporary accommodation, and it is hoped that a new laboratory will be built in the next few years. The new development is particularly welcome in view of the close association of Oxford with metal-using industries.

National Parks Commission

There are now eight national parks in Britain—the Lake District, the Peak District, Snowdonia, Dartmoor, the Pembrokeshire Coast, the North York Moors, the Yorkshire Dales and Exmoor, with a total area of 4,333 square miles—while two further areas have been designated as national parks—Northumberland and the Brecon Beacons. One of the duties of the National Parks Commission is to bring to the notice of the public the setting up of these parks and to explain why they have been set up. There is still much misunderstanding among the general public, and the Commission takes every opportunity to show that the designation of an area as a national park effects no change in the ownership of land. The land is not 'nationalized' nor does designation as a national park confer on the public any right of access. Users of national parks are asked to respect privately owned country inside the parks in the same way that they would outside. They are also asked to observe the "Country Code", a code of behaviour for visitors which has been set out in an attractive booklet by the Commission and which can be obtained from H.M. Stationery Office, price 4*d*.

Museum of English Rural Life, Reading

The first annual report of the Museum of English Rural Life at Reading, although dated 1955, covers the first four years of the existence of this rapidly growing institution. This Museum had the great advantage of starting from scratch and thus was able to determine its policy and administration, both of which were based on orthodox museum practice in Great Britain. Contrary to traditional custom, however, the report, rather than being a record of month-by-month activities, includes the abbreviated text of a lecture delivered by Mr. Uldall, keeper of Frilandsmuseet, the open-air section of the National Museum of Denmark. This lecture details some of the principles which are now slowly emerging concerning folk museums and folk parks and stresses the fact that the material acquired should be regarded primarily as objects for the basis of scientific study rather than exhibition pieces.

Beauty and Order

A FINELY illustrated article by Dr. P. Weiss in a recent issue of the *Scientific Monthly* (81, No. 6; December 1955) elaborates the regularity and consistency of design in living forms. The regularity is expressed in such features as symmetry, repetition and alternation of elements; and consistency, as in the use of curves, proportions, size gradients, and so forth, in subdividing space. The rule of order over randomness, of pattern over chaos, of law over accident is well brought out, while patterns in Nature are shown to be of both space and time. In the last analysis, each organic form has had its history and has come to be what it is through long sequences of developmental processes. Since all form is thus merely a momentary cross-section through a stream of formative and transformative processes, what is admired as order and beauty in the final form is only a product and an index of the measured orderliness of the developmental actions and interactions by which it has come about. Static form is only a precipitate of underlying and antecedent formative dynamics.

Population Structure in Salt-Marsh Song Sparrows

THE song sparrows (*Melospiza melodia*) that live on the salt marshes of San Francisco Bay, California, have attracted the attention of students of birds for the past sixty years. The principal reason for this has been their morphological distinctness from all other song sparrows, including those which live in areas close to the salt marshes. Such a pattern of differentiation and distribution has always raised the problem of how the salt-marsh populations maintain themselves as distinct entities. A study by Richard F. Johnston continues previous work on salt-marsh song sparrows to determine what characteristics of salt-marsh populations influence or have some relationship to the maintenance of their morphological and/or genetical integrity, and how these characteristics express themselves (*Condor*, 58, No. 1; January–February 1956). Factors influencing the initiation of breeding in the song sparrow are closely associated with the biological growing season and include the photoperiod, temperature of the preceding three months, and the amount and distribution of the winter rainfall; these also influence the amount and quality of the song sparrow's food, which may well be the most proximate factor. The inception of breeding seems not to be closely related to any 'temperature threshold' or 'warmth-sum'.

Breeding spans the period March–June; the peak of first nestings is at the end of March. This is more than two weeks earlier than in upland song sparrows at the same latitude and seems to represent an adaptation to marsh life, for the birds thus nest mainly during lower tidal conditions. It is not the absolute height of the tides that governs egg and nestling mortality, but whether or not the birds can nest early enough to escape the high run of tides in April to June; when they breed late, there is high mortality caused by the high tides. Male song sparrows set up territories during late autumn and winter and are completely territorial by late February. Territorial defence is lacking during July–September when the adults moult; autumnal territoriality is seen in mid-September. Adult birds rarely shift their territory from one breeding season to the next. Dispersal of juveniles occurs in the late spring and summer and halts in late August and September when territorial activity rises. The median distance of dispersal, hatch-site to breeding-site, for 34 song sparrows was 185 metres. The limited adult movement and restricted distance of dispersal of these song sparrows mark them as one of the most sedentary population of birds yet investigated.

Predator Control

THE *Bulletin of the International Union for the Protection of Nature* (5, No. 1; April 1956) includes an account of the effects of attempted predator control in America. On the Kaibab Plateau in north-western Arizona, an area so noted for its mule deer that it was made into a game reserve more than fifty years ago, cougars and wolves were trapped to ensure that the deer would be protected. Within a few years the deer population had increased to such an extent that pasture-land was exhausted and even the forest was damaged. As a result, thousands of deer starved because of loss of their food supply. On Valcour Island, in Lake Champlain, an investigation was carried out to test the possibility of augmenting game by means of successful predator control. This operation allowed the game, mainly ruffed grouse and hares, to increase during the first four years from a small to a moderately high level, and then the population began to decline. In the absence of predation, disease apparently became a major limiting factor. As the sick were no longer eliminated, unchecked epidemics ravaged the game which was to be protected.

A Virus Latent in Turnips

J. P. MACKINNON has reported on this phenomenon as follows (*Canad. J. Bot.*, 34, 1, 131; 1956). Green peach aphids reared on turnip stecklings acquired a virus that was transmitted to plants of *Physalis floridana* Rydb. and *P. pubescens* L., hosts used in potato leaf-roll studies. Symptoms on these hosts consisted of a yellowing of the veins of the leaves. *Nicandra physalodes* L., when infected, showed severe stunting and chlorosis. The virus was carried without symptoms on turnips and showed only slight stunting on several species of *Brassica*. It was not transmitted by mechanical inoculation, and it does not appear to be similar to any of the viruses previously reported in turnips. The aphid *Myzus persicae* (Sulzer) acquired the virus during a seven-hour feeding period, and after a latent period of approximately 23 hr., transmitted the virus during a one-hour test-feeding period. Once infective, aphids remained so for several days.

American Prairies

IT has long been held that the vast extent of grassland, which is almost treeless, extending from western Indiana to the eastern slopes of the Rocky Mountains was made by man and due to the 'fire hunting' of Indian tribes. Among many tribes, fire drives were used in the pursuit of bison and other large-game animals. Whatever their purpose, such fires ran unchecked until they reached a stream or other baulk. Repeated burning destroyed existing trees and prevented their replacement by new growth. This belief has now been challenged by an American archæologist, Dr. W. R. Wedel (Smithsonian News Release, Dec. 23). Studies of habitation sites show that there were great dust movements over the plains before there was any agriculture. The dust, he suggests, must have been picked up from dry uplands from which the grass had been killed by drought. Geological surveys also show that there

were typical grassland soils in the area throughout the ice ages. They were typical of each recession of the glacier and are now buried deep under the present land surface. At present, natural tree growth is practically restricted to river-bottom lands and ravines, and there is very little tendency for the woodlands to spread out over the plains.

The Weather Service in Great Britain

A NEAT little pamphlet entitled "Your Weather Service", prepared by the Meteorological Office and Central Office of Information (revised edition; pp. 52+8 plates. London: H.M.S.O., 1955; 1*s.* 6*d.* net), describes in popular form the organization of the Meteorological Office, the making of meteorological observations, and their collection and use both in weather forecasting and in the longer-term climatological work which the Meteorological Office performs in its capacity as the public memory of the weather. The terms used in broadcast weather forecasts are defined, and maps show the areas used in the forecasts broadcast for the British Isles and the adjacent sea areas. The pamphlet gives full details of how to obtain special weather forecasts and meteorological advice, and ends with a table of the normal temperatures of each month in each of the areas used in the broadcasts and a detailed table of mean and extreme temperatures, sunshine, relative humidity, fog, thunder, snow and wind at Kew Observatory. Plates show the making of surface and upper-air observations and their collection, the plotting of them on charts, and the testing of instruments. One plate shows in diagrammatic form the very wide sphere of applications from which inquiries are received in the British Climatology Branch of the Office, ranging from "where to live" to the design of cooling towers at power stations. On the much-discussed subject of "old-fashioned summers", there is no evidence that Britain is either warmer or colder than it was a century ago. The pamphlet describes the services of reference on the spot and of lending of the Meteorological Office Library, which contains the greatest collection of meteorological literature in Britain and is one of the largest in the world. The pamphlet also gives an outline of the publications, from the Daily Weather Report to the highly specialized research series of Geophysical Memoirs prepared in the Office.

Geophysics in Pakistan

THE director of the Meteorological Service of Pakistan, Mr. S. N. Naqvi, began last year the publication of a duplicated series entitled "Geophysical Review". Part 4, "Technical Progress Review, No. 7" (September 30, 1955), describes the current state of geophysical research in Pakistan, and in particular the work in progress on atmospheric physics, geomagnetism and seismology. In cloud physics, condensation on large hygroscopic particles has been studied under the guidance of Dr. E. M. Fournier d'Albe, and trials of cloud-seeding by spraying salt particles into the air have been made. Actinometers have been brought into use and their records analysed to obtain the usual statistics of solar radiation and the 'measure of turbidity' which is the exponent of the Rayleigh transmission factor of the solar beam. The Agrimeteorological Observatory has worked on soil temperature and water content at depths up to 1 m. in an orchard in relation to the minimum water requirements of the fruit trees. The Geomagnetic Section has studied the variation of the scale values and temperature coefficient of the horizontal force magnetometer, ionospheric structure and, with a Dobson spectrometer, the variation in ozone content of the air. The Seismological Observatory has installed accelographs at Quetta and Sylhet (East Pakistan), the records of which will be valuable in the construction of buildings to resist earthquakes, and has made detailed studies of the recent larger shocks in the Dominion. Geophysical research is developing rapidly in Pakistan, and the Meteorological Service of Pakistan, one of the most recently formed such services in the British Commonwealth, is doing valuable service in publishing this record of progress up to date.

Higher Education in the United States

IN the September issue of the *Annals of the American Academy of Political and Social Science*, under the title "Higher Education under Stress", is presented a comprehensive picture of the issues confronting higher education in the United States. Three general papers, by F. J. Brown on a long-range view of higher education, by G. K. Chalmers on the purpose of learning, and by M. H. Trythen on meeting manpower needs, are followed by eight others dealing with specific issues in the United States. These are of slight interest to the British reader, with the exception of Dr. H. D. Gideonse's "Academic Freedom: a Decade of Challenge and Clarification" and Dr. H. E. Wilson's review of the role of the university in international relations; but for these two papers alone the number will be welcomed by many in Britain. The greater part of the issue is devoted to the papers presented at the Conference on Methods of Financing Higher Education, held in Philadelphia during May 20–21, 1955. For the most part they are concerned with specifically American issues which have no close counterpart elsewhere, and, while the issue forms an admirable supplement which brings up to date J. D. Millett's report on "Financing Higher Education in the United States", published in 1952, except for the papers indicated it throws little light on the problems with which the university administrator or teacher in Britain is confronted.

Education through Physics

WHAT qualities does the world expect of a well-educated man? That he should have a tough and inquiring mind, able, and indeed anxious, to tackle new problems, new situations. That he should be creative, not hidebound, independent and not relying solely on the minds of others. That he should be well informed generally and really knowledgeable about certain subjects or parts of subjects. That he should appreciate spiritual and æsthetic values. That he should be intellectually honest, able to recognize a hard fact, and not afraid to give up preconceived ideas in the face of demonstrable proof. That he should be able to express himself clearly, convincingly and concisely in writing and in speech. That he should be able to live with and collaborate with others, showing the tolerance which arises from an understanding of studies and beliefs other than his own, but not tolerance of slovenliness of any kind. That he should exhibit the qualities of perseverance and humility, and above all, of judgment. These views were put forward by Prof. F. A. Vick at a meeting of the Education Group of the Institute of Physics. Prof. Vick does not pretend that all these qualities can be acquired solely from courses in physics, although he believes that most, if not all,

of them can be developed by contact with some physicists. A great deal more could be done to educate students' minds than is sometimes done. Courses in the physical sciences could make contributions to the education of the mind which few other subjects can.

Science Masters' Association

BESIDES details of a wide range of activities in 1955, the annual report of the Science Masters' Association contains one item which reflects the enthusiasm and enterprise of its members. Its radioactive isotopes sub-committee has continued to investigate the possibility of producing experiments suitable for schools. Much research has been carried on to devise suitable and inexpensive apparatus, especially that which can be put together in the school itself. The sub-committee is particularly anxious to recommend experiments which can be done by use of radioactive isotopes only, or can be done more effectively by their use than by the conventional methods used hitherto. The sub-committee does not look with favour upon the use of fundamental particles as 'wonders' but desires to make use of them as 'tools', an adjunct to technique rather than a new body of phenomena to be added to an already over-filled syllabus. Progress in this work has been delayed because the necessary Statutory Panel demanded by the Radio-active Substances Act has not yet been set up by the appropriate Government departments. Recently steps have been taken by the Ministry of Education to form such a Panel, and publication may shortly be expected of the schedule defining the limits within which experiments in schools will be permitted.

Announcements

PROF. JOHN F. FULTON, of the Yale University School of Medicine, has recently received an honorary doctorate of medicine of the University of Upsala.

THE following appointments have been made in the University of London: Dr. W. S. Peart, senior lecturer in St. Mary's Hospital Medical School, to the University chair of medicine tenable at that School; Dr. Harry Wilman, lecturer in applied physical chemistry in the Imperial College of Science and Technology, to the University readership in applied chemical physics tenable at that College.

THE sixth Parliamentary Conference on World Government will be held in the County Hall, London, during July 28–31. Further information can be obtained from the secretary-general, G. McAllister, 21 Hampstead Lane, Highgate Village, London, N.6.

THE next Cytological Congress will be held at the University of St. Andrews, Scotland, during August 28–September 3, 1957. Admission will normally be restricted to members of the Society for Cell Biology and their guests. Others wishing to attend should communicate with the secretary of the Congress, Prof. H. G. Callan, Department of Natural History, The University, St. Andrews, Scotland.

THE U.S. Combustion Institute will hold its sixth international symposium in Yale University during August 19–24. A large number of aspects of combustion will be discussed; but in general the purpose of the symposium is to consider new experimental results and advances in theory, as well as their application in engineering practice. Further information on the technical programme can be obtained from the Combustion Institute, 200 Alcoa Building, Pittsburgh 19, Pa. Those wishing to attend the symposium should write to the Combustion Symposium Office, Mason Laboratory, Yale University, 400 Temple Street, New Haven 11, Conn.

THE British Society for Research on Ageing has planned a joint meeting with Dutch gerontologists, to be held in Amsterdam on the afternoon of July 27 and following morning. The meeting is open to all, and those attending the International Physiological Congress in Brussels, commencing on July 30, may find it convenient to attend the Amsterdam meeting *en route*. Further information can be obtained from the honorary secretary of the Society, Dr. G. H. Bourne, London Hospital Medical College, Turner Street, London, E.1.

THE eighth British Mathematical Colloquium will be held in the University of St. Andrews during September 4–6. The subjects for discussion on the respective days will be algebra and the theory of numbers; analysis; and geometry and topology. As in previous years, the Colloquium is open to university academic staff, Civil servants in scientific departments and, subject to limitations of accommodation, to research students. The membership fee is 10*s*. Application for membership should be made to D. Borwein, Department of Mathematics, St. Salvator's College, St. Andrews, from whom further information can be obtained.

A JOINT meeting of Commissions I and II of the International Institute of Refrigeration will be held in Louvain during September 4–7. Four general topics will be discussed: methods for the detection at very low temperatures of traces of impurities in metals, semiconductors and other solids (magnetic susceptibility, electrical resistance, electronic resonance, heat conductivity, etc.); heat conductivity and viscosity coefficients of gas and liquid mixtures at low temperatures; relationship between insulating materials and the gas or vapour included; and hygrometry. Those interested in attending should write to Prof. I. van Itterbeek, Naamsestraat 73, Louvain, Belgium, from whom further information can be obtained.

A EUROPEAN mycological congress will be held in Brussels during September 15–22, and all persons interested in the study of higher fungi are invited to attend. This is the first such meeting, and it is proposed to repeat it at three-year intervals. The working languages will be French, English and German. Further information can be obtained from Dr. P. Heinemann, 26 Rue J. W. Wilson, Brussels.

Immediately after the congress a symposium will be held in the University of Liège on the ecology of higher fungi. Those interested should write directly to Dr. F. Darimont, Institut Botanique de l'Université, 3 Rue Fusch, Liège, indicating the subjects they would like to be covered.

A FOURTH list of amendments to the third edition of the "World List of Scientific Publications", including amendments to library holdings after the date of publication, has been published by the Documentation Committee of the Society of Chemical Industry in *Chemistry and Industry* (1955, 1764–67). Details of any errors discovered in the "World List" should be sent to: Miss M. I. Wyatt, The Laboratories, J. Lyons and Co., Ltd., 149 Hammersmith Road, London, W.14.

BRITISH RAYON RESEARCH ASSOCIATION

OPEN DAYS

THE British Rayon Research Association held open days during May 10–11 at its laboratories at Heald Green, Wythenshawe, on the south side of Manchester. These open days are intended to be an annual event in future. Representatives of member firms, universities, technical colleges, trade associations, the Department of Scientific and Industrial Research, other research associations, scientific and technical societies, and trade unions took advantage of the invitation to inspect the Association's work. This can be divided into three main sections: fundamental research, which absorbs approximately 40 per cent of the effort; applied research, including machinery development and instrumentation, which absorbs a further 40 per cent; and member service.

The fundamental research can be briefly described as an investigation into the chemical and physical structure of cellulose and into its physical properties interpreted in terms of structure. It is, of course, impossible to indicate in detail all that is taking place; but very considerable progress has been made in elucidating the precise molecular arrangements in the various crystalline forms of cellulose. In this connexion the use of infra-red spectroscopy has proved particularly valuable. By means of a new technique—that is, the replacement of hydrogen in the amorphous region by deuterium—it has been found possible to separate the absorption of the crystalline regions of cellulose from that of the amorphous regions, and thus to study each region separately. The method has established the fact that two of the oxygen atoms in each pyranose unit are proton donators only, and that two of them are both proton donators and acceptors. The use of polarized infra-red gives the direction of each hydrogen bond. All this information is being carefully collated with the information obtained from X-ray analysis of crystal structure, and from organic and from physico-chemical studies.

Work is proceeding on strain birefringence. The basic theory has been worked out, and the technique has been applied to a study of the stress-relaxation of polymers at constant length. Three typical modes of photo-elastic behaviour are possible: in polymers of amorphous network the birefringence decreases with the stress; in crystalline polymers the birefringence remains constant during the relaxation; and in polymers in which stretching induces crystallization the birefringence increases as the stress decreases. In other words, the method can be, and is being, used for obtaining information regarding the physical structure and the deformation mechanism of polymers.

Two organic groups are concentrating their attention on the breakdown of cellulose during the alkali refining of tyre cord pulp, since very heavy losses take place at this stage. It is possible that the losses could be avoided if we understood better the precise mechanism of the process.

Two groups of physical chemists are studying the kinetics of the photochemical breakdown of cellulose. They have already elucidated the essential mechanism of the process; that is, that the dyestuff, under the action of light, assumes the activated triplet state and in this state it removes a hydrogen atom from the cellulose molecule. A free radical is thereby produced, which promptly combines with molecular oxygen to yield a peroxide radical which initiates the breakdown.

This work involves a study of the transient states of dye molecules, for which Prof. G. Porter's flash-photolysis technique is peculiarly suitable. A qualitative survey of the field is now complete, the spectra of all the transient states of duroquinone have been identified, and quantitative work has been commenced. It is being extended to reactions in the solid state.

The Association's technological work includes a large programme of work on blended yarns. Viscose is being mixed with acetate, cotton, nylon, 'Terylene' and 'Orlon' in turn, spun into yarn and woven into cloths of shirting and gaberdine construction. The cloths are being dyed and finished in several ways and then tested. So far as the work has gone, it is clear that in the spinning, warping and weaving there are no outstanding difficulties in producing cloths from blends. Some problems have been encountered in dyeing and finishing; but it is not expected that they will be insuperable.

Visitors showed considerable interest in the Stains direct spinner, which produces spun yarns from continuous-filament tow. The work so far has been concerned mainly with the production of viscose yarns, for which tows are fairly readily available in Britain.

An intense effort is being devoted to the short processing of rayon. The basis for the method lies in a new 3-over-4 draw frame developed by the Association. This produces a much more regular sliver than normal, with the result that at least one set of speed frames can be eliminated and single packages can be used on the ring frame, with a saving of more than 2*d*. per lb. in yarn spinning costs. Improved instrumentation is playing a vital part in this work, since it enables the mill manager to detect at once whether any of his frames are likely to give trouble.

Other machinery developments are in hand, including an important chemical engineering project recently launched. The Association is attempting to apply fluid bed techniques to yarn and fabric drying, dyeing and finishing. At first pilot plant and then full-scale plant are being erected for each application, with the view of collecting the information on which the design of commercial plant can be based. An association of British machinery manufacturers has been formed to put the invention on the market. The method offers great potential savings. For example, it is possible to dye hydrophobic fibres such as 'Terylene' and nylon by a continuous process in ten seconds instead of taking several hours in pressure vessels in batch processes. Resin baking can be carried out in twenty seconds instead of three to four minutes. Spun nylon can be singed in a tenth of a second.

Various instruments designed originally by the Association for research purposes are now being manufactured and sold by instrument firms. The

two instruments which have proved most popular are the yarn speed indicator and the loom setting indicator.

The Association runs a very active member service section, which provides literature and patent surveys, examines and reports on defective fabrics, and gives immediate assistance on factory production difficulties.

The staff numbers 260, made up as follows: research staff, 86; laboratory and technological assistants, 82; engineering, drawing office, and maintenance staff, 55; and library and administrative staff, 37. The Association has just agreed to the new terms of grant for the next five-year period, under which the industry is to subscribe £270,000 a year, against a grant from the Department of Scientific and Industrial Research of £90,000 a year, although the expenditure, which for the current year is to be £322,000, will not build up to £360,000 until the end of the five-year period.

POLYMERS, BIOCOLLOIDS AND POLYELECTROLYTES

SYMPOSIUM IN ISRAEL

UNDER the title of "Polymers, Biocolloids and Polyelectrolytes in Solution" an International Symposium on Macromolecular Chemistry was held in Israel during April 3–9 under the auspices of the Commission on Macromolecules of the International Union of Pure and Applied Chemistry and the Weizmann Institute of Science, Rehovot. This was the first time that such a symposium had been held outside America or Western Europe, and the efficiency of the arrangements and success of the meeting completely justified the choice. More than a hundred foreign scientists attended, including delegates from the U.S.S.R. and Eastern European countries, in addition to an Israeli group of the same size. Sessions were held in the Weizmann Institute, the new campus of the Hebrew University of Jerusalem, and the Institute of Technology at Haifa. It is typical of the rate of development in Israel that meetings in all three centres were held in auditoria that had been completed only recently.

In addition to eighty papers, lectures summarizing recent developments in polymerization were given. The topics discussed were the Ziegler-type polymerization of olefines (Mark, of New York), organic reactions of vinyl polymers (Smets, of Louvain) and the effect of high-energy radiation on vinyl monomers and polymers (Magat, of Paris). More specialized lectures were also given at the start of every session. Space permits no more than a mention of most of the papers that were presented, and for the same reason it is impossible in some cases to give all the authors' names.

The first section of the symposium dealt with the general behaviour of polymers in solution, and included lectures on the statistical thermodynamics of polymers (Prigogine, of Brussels), hydrodynamic properties of polymer solutions (Hermans, of Leyden) and a hydrodynamic study of sedimentation and diffusion (de Groot, of Leyden). Calculations have been made of the molecular extensions of polysaccharides and polybutadienes (Eliezer and Hayman, of Jerusalem), and the matrix method employed in the theory of ferromagnetism has been shown to be useful in statistical problems involving polymers (Hill, of Bethesda). Departures from random mixing in polymer-liquid systems were considered by Gee (Manchester), and Rinfret (Montreal) summarized his recent accurate measurements of heats of mixing and partial specific volumes of polymer solutions, both of which show discontinuities that are dependent on molecular weight. Studies of the viscosity (Rempp, of Strasbourg) and vapour pressure and heat of dilution (Banderet, of Mulhouse) of solutions of paraffins and simple derivatives have been made. Interaction between solvents and cellulose derivatives (Moore, of Bradford) or nylon 66 (Valentine, of Leeds) has been measured by various techniques. Staverman (Delft) described an osmometer the 'membrane' of which is a vapour slit between two disks of sintered glass, and experiments in which diffusion through a conventional membrane was measured. The velocity of dissolution of polystyrene has been shown to depend on the molecular weight and can, after standardization, be used for measuring molecular weights (Ueberreiter, of Berlin). Studies on viscosity included the effect of shear (Eisenberg, of Rehovot) or capillary size (Lifson, of Rehovot) and the anti-thixotropy shown by solutions of poly*iso*butylene in tetralin (Crane and Schiffer, of Haifa).

Optical and electro-optical investigations were described in several papers by Cerf, Leray and Wippler (Strasbourg), Janeschitz-Kriegl (Delft), Peterlin (Ljubljana), Tsvetkov (Leningrad) and in a lecture by Sadron (Strasbourg). The present increased interest in the dielectric properties of solutions of polymers was reflected by papers by van Beek and Hermans (Leyden), de Brouckère (Brussels), Marchal and Benoit (Strasbourg) and Mandel (Brussels). For high degrees of polymerization, the root-mean-square dipole moment is found to be proportional to the square root of the degree of polymerization.

Several papers dealt with the solution behaviour of highly polar polymers. Morawetz (New York) stressed the importance of local concentrations in the molecular coil in determining the formation of association complexes. Viscosimetric and turbidimetric studies suggest that polymethacrylic acid is strongly intra-molecularly bonded, and that this may be responsible for its negative thixotropy (Eliassaf, Silberberg and A. Katchalsky, of Rehovot). The solution behaviour of chemically synthesized, branched polyglucoses (Mora, of Oxford) and the coacervation of polyamides (Turska, of Lodz) were also discussed.

As might be expected from the strong interest of Israeli scientists in this field, the behaviour of biocolloids and polyelectrolytes in aqueous solution was thoroughly discussed. Fuoss (New Haven) initiated the session with a lecture, and papers on theoretical aspects were presented by Oosawa (Nagoya), Lifson (Rehovot) and Michaeli and Overbeek (Utrecht). Topics discussed included the effect of the size of gegen-ions (Gregor, of New York) and the distance between ionizing groups (Dobry-Duclaux, of Paris). The experimental determination of the charge on the polymethacrylate ion was discussed by Jordan (Adelaide), and a new simple theory of polyelectrolytes which leads to good agreement between experiments on velocity of migration, conductivity and activity was presented by Dobry-Duclaux. Other polyelectrolytes that were discussed were polyvinylamine hydrobromide and polyvinylpiperidine (A. Katchalsky), vinyl amphoteric polyelectrolytes (Alfrey

and Pinner, of New York), lithium polyphosphate (Saini, of Turin), polymethacrylic acid (Kryszewski, of Torun, Poland), sodium alginate (Allgen, of Stockholm) and the sulphate of aminoacetalized polyvinyl alcohol (Matsumoto, of Okayama). The electroviscous effect shown by rigid polyelectrolytes (Donnet, of Mulhouse), the interaction of ionized polyelectrolytes with polarized mercury-water interfaces (Miller, of Rehovot) and the potentiometry of polyelectrolyte gels (Michaeli and A. Katchalsky, of Rehovot) were also discussed. The unequal permeability to different ions of hydrophilic membranes impregnated with polyelectrolytes, particularly the copper ferrocyanide and sulphuric acid/'Cellophane'/barium hydroxide membranes, was studied by Hirsch-Ayalon (Utrecht).

In the field of protein and polypeptide chemistry, two papers on the surface chemistry of synthetic polypeptides (Isemura, of Osaka) and gliadin and zein (Jaffe, of Brussels) were presented. The deuterium exchange of poly-DL-alanine with water suggests that it exists in aqueous solution in a folded, possibly helical form (Berger and Linderström-Lang, of Copenhagen), while a reversible transformation between helix and random coil has been found for solutions of poly-L-glutamic acid (Doty, of Harvard; Blout, of Boston). A general review of the solution behaviour of poly-α-amino-acids was given by E. Katchalsky (Rehovot), and the reversible heat coagulation of some of these was described by Noguchi (Kanazawa). Polybases (for example, polylysine) agglutinate red blood cells, altering their surface potentials (Nevo, de Vries and A. Katchalsky, of Israel), Meyer (New York) reviewed recent developments in our knowledge of the structure of connective tissue, and other proteins investigated were bovine serum albumin (Champagne, of Strasbourg) and actomyosin (Wassermann, of London).

Nucleic acids were also discussed in several papers and in two lectures by Jordan (Adelaide) and Watson (Cambridge, Mass.). These polymers have been investigated by a variety of physico-chemical techniques: for example, the ultra-centrifuge (Shooter and Butler, of London; Desreux, of Liège), light-scattering (Pouyet and Weill, of Strasbourg), streaming birefringence (Wahl, of Paris; Mathieson, of Nottingham), electrophoresis (Mathieson) and titration (Peacocke, of Birmingham; Mathieson).

Carbohydrates also received some attention. In a most interesting paper, Usmanov (Tashkent) discussed the physico-chemical behaviour of native cellulose and showed that the molecular weight increases steadily as the cotton fibre becomes older, so that the biosynthesis of cotton is apparently a polycondensation process. Spectroscopic studies of the ageing of starch were described by Samec (Ljubljana), while other carbohydrates investigated were levan, a polymer of D-fructose (Feingold and Gehatia, of Israel) and the cycloglucans (Freudenberg, of Heidelberg). Although cupriethylene diamine and cuprammonium hydroxide can be used as solvents in the molecular fractionation of cellulose, they are not recommended because of the degradation that may occur (Sihtola, of Helsinki). Theoretical aspects of polydispersity were considered by Hultin (Stockholm) and Daune (Strasbourg). The swelling of regenerated cellulose (Nowakowski, of Lodz), the sorption and diffusion of organic vapours by ethyl cellulose (Barrer and Barrie, of London) and adsorption on glass-like polymers (Kargin, of Moscow) were also investigated. The flexibility in solution of molecules of hyaluronic acid was reported by Rowen (Los Angeles).

Miscellaneous studies on vinyl polymers included the effect of branching on the solution properties of polyethylene (Trementozzi, of Springfield, Mass.; Mussa, of Turin), the irradiation of polymers in solution (Charlesby and Alexander, of England), the swelling of graft copolymers of acrylonitrile on polyethylene (Chapiro, of Paris) and the preparation of various graft copolymers (Mesrobian, of Brooklyn). Finally, the preparation and properties of several nitrogen-containing polymers were described: for example, polyaminocarboxylic acids and polyvinylamides (Smets, of Louvain) and poly-N-vinylpyrrolidone (Breitenbach, of Vienna).

It is to be hoped that this highly compressed survey gives some idea of the tremendous variety of topics discussed. This catholicity was deliberate, as one of the objects of the organizers was to bring together workers on biocolloids and synthetic polymers so that cross-fertilization of ideas could take place. Judging by the animated discussions that took place inside and, to an even greater extent, outside the lecture halls, this aim was fulfilled. All the papers, together with the discussions, will be printed in full in a special issue of the *Journal of Polymer Science*.

L. Valentine

PROGRESS IN THE STUDY OF THE BRITISH FLORA

KNOWLEDGE of the British flora has advanced during the past decade at a rate which has never been equalled before. New techniques and a fresh approach to old problems have resulted in rapidly increasing progress, and the present is therefore an appropriate time for review of old and new methods with the object of suggesting the most fruitful lines for future development. This was the purpose of the conference arranged by the Botanical Society of the British Isles under the title of "Progress in the Study of the British Flora", which was held in Bedford College, London, during April 13–14.

The conference was opened by Prof. T. G. Tutin (University College, Leicester), who directed attention to the importance of learning to regard the flora of the British Isles as a small part of that of Europe. The insularity of British workers has not yet been entirely broken down, and a wider view can have important consequences for the future progress in the study of the British flora. To know their flora properly, British workers must enlarge their scope, and a start in this direction has already been made by experimental taxonomists and specialists in certain genera. Prof. Tutin suggested that the Society could play a valuable part in helping workers to take this wider view, and this proposal was enthusiastically supported by later speakers.

Most of the first day was devoted to consideration of old methods. Canon C. E. Raven discussed "The Early Development of a Knowledge of the British Flora". He pointed out that William Turner, the 'Father' of English botany, had little success in his efforts to identify English plants in the classical botany books until he travelled abroad. As soon as he came across the dried herbaria of Luca Ghini and the admirable pictures in Brunfels, his task became manageable. The discipline which this primary business of nomenclature involved was an exacting,

and therefore very valuable, preparation for botanical studies: it gave to these early students a power of detailed observation and minute discrimination which has seldom been surpassed. Ray very seldom confused species that we distinguish, or, except when he relied on hearsay evidence, described plants which we cannot easily and accurately name. This primary business of naming, and its sequel in arrangement and classification, gave rise to study of the habitat and of problems of plant structure and physiology, and the seventeenth-century botanists got as far as was possible until the basic sciences emancipated themselves from magic and tradition. During the discussion which followed Canon Raven's paper, attention was directed to the value of these old records as a starting-point for new investigations. It is significant that some species, such as *Veronica spicata* in Cambridgeshire, have remained for a period of three centuries in the same localities without extending their range, while others have shown rapid spread in much shorter periods.

The next paper, by Mr. J. E. Lousley, considered "The Contribution of Exchange Clubs to Knowledge of the British Flora". When large-scale organized exchange of herbarium specimens was started in Edinburgh and London in 1836, facilities for studying dried and localized dried material were very limited indeed. For the first twenty years, their efforts were directed towards supplying herbarium specimens in large numbers to meet the need of the time. From 1857 to 1878 there was a transitional period when emphasis passed from mere exchange to the study of critical plants, which was their proper function for the remainder of their history. They provided much of the standard material now available for consultation, and the notes printed in the reports provide a record of the views of contemporary botanists on these specimens. By focusing attention on variation, they brought to notice almost all the segregates which cytology or other modern methods have shown to be of importance, and many hints for useful new work may still be found by examination of old reports and the specimens to which they refer.

Dr. J. G. Dony then followed with a paper on "The Place of the Local Flora in the Study of the British Flora". He suggested that local floras have been largely responsible for making Britain, from the botanical point of view, the best-studied part of the world and have served to collect together information on the behaviour of our plants in addition to detailed data on their distribution. There is hope that a fresh pattern for local floras will emerge from the new methods of study now available. The system of working on the basis of the squares of the National Grid which is being used for the new Cambridgeshire, Derbyshire and Warwickshire Floras shows considerable promise.

Prof. P. W. Richards described the progress of the "Biological Flora" which is appearing in parts as supplements to the *Journal of Ecology*. Since active work on this project commenced in 1940, accounts of seventy-four species have been published, and about a hundred and sixty more are in preparation; although contributors work to a schedule, the plan allows for considerable elasticity in the treatment of individual species. Several suggestions for increasing the scope of this very useful work emerged from the discussion which followed. These included a plea for more detailed cytological information, a request for really full descriptions of each species to cover characters omitted for lack of space in most descriptive floras, and a suggestion that there is a need for a central office on the lines of the Maps Scheme of the Botanical Society of the British Isles to collect autecological information and give assistance and encouragement to volunteers.

On the second day of the conference all the speakers were concerned with recent developments. Mr. Keith Jones (Welsh Plant Breeding Station, Aberystwyth) directed attention to the importance of current work in cytology in his paper on "Some Aspects of Plant Variation: the Grasses". It is common knowledge that a species is not necessarily characterized by one chromosome number alone, but may embrace forms having two or more different numbers; perhaps it is not so well realized that there can also be pronounced intraspecific variation in chromosome pairing at meiosis. This can give important information about the nature and evolutionary origin of a species. Mr. Jones showed from examples that cytological work on artificially reared seedlings can give very different results from similar work on natural populations of the same species. The experimental taxonomist is concerned with the species as it exists after natural selection has operated, and for this purpose it is necessary to collect plants in the field. Studies based on a few individuals are of limited value, and in all cases it is important that the source of material used for chromosome determinations should always be clearly stated in publications.

"The Importance of Experimental Ecology in the Study of the British Flora" was the subject of a contribution from Dr. F. H. Whitehead (Department of Botany, University of Oxford). He pointed out that descriptive ecology discloses problems and suggests hypotheses which should then be tested by experimental work at various levels of refinement. One of his examples covered recent work at Oxford on two calcifuges, *Galium saxatile* and *Holcus mollis*, and two calcicoles, *Scabiosa columbaria* and *Asperula cynanchica*. When *Scabiosa columbaria* was grown in standard water cultures, one with a high *p*H and the other with a low *p*H, there was no significant difference in the growth of the plants, and yet when grown from seed in contrasting soils the plants behaved quite differently. These differences were maintained in water cultures prepared from soil adjusted to high and low values of *p*H. It was concluded that the soil substance affecting growth was water-soluble, and likely to be aluminium. In water cultures with aluminium salts added, *Scabiosa columbaria* behaved in the same way as in cultures prepared from acid soils and produced a small and malformed root system. Thus, on acid soils containing aluminium this plant would be eliminated at the seedling stage during a period of drought. Although it grows especially on soils with a high *p*H due to a high proportion of calcium carbonate, it will grow equally well on soils rich in other bases—the effect of calcium carbonate is only secondary in making the aluminium not available to the plant. Very similar results were obtained for *Asperula cynanchica*. Examples of this kind show that problems are much more complex than has been hitherto believed, and Dr. Whitehead concluded with a plea for more experimental work of an autecological nature.

Dr. F. Rose (Bedford College, London) opened his paper with a similar plea. In considering "The Importance of Relict and Disjunct Distributions in the Interpretation of the History of the Present British Flora", he put forward hypotheses explaining modern distributions in terms of post-glacial historical

changes with the view of stimulating detailed autecological work on the groups of species he mentioned. Dr. S. M. Walters (Botany School, University of Cambridge) gave a survey of the history of mapping plant distributions. In Britain, H. C. Watson in 1836 published a clear statement of the different possible methods to be adopted—area outline, vice-county, and dot maps as they later developed—but, apart from Miller Christy's map of the oxlip in 1884, his ideas were not followed up. The first published vice-county maps for the whole of the British Isles appear to be those in Sir Edward Salisbury's "East Anglian Flora" (1932), although county maps had been included in the "Cambridge British Flora" (1914–20). In visual presentation of distribution data, we have made a much later start than other European countries. Dr. Walters suggested that we could repay our debt to European phytogeography by proposing a practical, standardized method to map the European flora, and he exhibited the outline of such a method.

In the last paper delivered to the conference, Prof. D. H. Valentine (University of Durham) considered "The Study of our Flora as Part of a Whole". Using the family Primulaceae as his main example, he demonstrated the importance of looking at the British flora as a constituent part of the boreal flora as a whole, and emphasized the importance of combining cytogenetical and taxonomic investigations. He urged co-operation with botanists in Europe and the production of a European Flora as outstanding needs.

In addition to the main papers, six exhibitors read short accounts of their exhibits. Mr. A. D. Bradshaw (Department of Agricultural Botany, University College of North Wales, Bangor) described an investigation of the *Agrostis* population of a very old pasture, Port Meadow, Oxford. The composition of a sample of sixty plants on a morphological basis, confirmed by pollen fertilities, was shown to be *A. tenuis* 1½ per cent, *A. stolonifera* 3½ per cent, plants of F_1 type 70 per cent, and plants not easily ascribable to these categories, presumably F_2's or back-crosses, 25 per cent. The population is therefore composed almost entirely of sterile hybrid plants able to compete successfully with their parents under heavily grazed conditions. Miss M. E. Bradshaw (University of Durham) reviewed the distribution of the segregates of *Alchemilla vulgaris* aggr. in Britain, Mr. P. A. Gay (University College of Wales, Aberystwyth) discussed the taxonomic status of *Erica mackaiana*, and Mr. K. M. Goodway (University College of North Staffordshire) the morphological and cytological types of *Galium pumilum*. Mr. D. M. Moore (University of Durham) considered the status of *Viola lactea*, and Dr. W. S. Lacey (University College of North Wales, Bangor) described the spread of *Galinsoga parviflora* and *G. ciliata* in Britain.

Looking back over the two days of the conference, it is clear that there was general agreement that the most promising lines for furthering our knowledge of the British flora are yet closer collaboration between field and laboratory studies, and greatly increased collaboration with European botanists. It was remarkable how these general proposals kept cropping up in almost every paper and throughout the discussions, and there was enthusiastic support for some of the measures suggested for putting them into practice. The proceedings of the conference will be published by the Botanical Society of the British Isles later this year in a book under the same title.

J. E. Lousley

THE POSITIVE CONTRIBUTION BY IMMIGRANTS

A SYMPOSIUM, "The Positive Contribution by Immigrants", prepared for the United Nations Educational, Scientific and Cultural Organization by the International Sociological Association and the International Economic Association (pp. 203. Paris: Unesco; London: H.M.S.O., 1955; 600 francs, 12*s.* 6*d.* or 2.25 dollars), includes five national studies covering the United States, Great Britain, Australia, Brazil and the Argentine Republic. There is also a short survey of the economic aspect, by Brinley Thomas, which details some of the outstanding inventions or industries in the United States attributed to immigrants and suggests that the qualitative contribution of immigrants as a source of outstanding talent and of general man-power is likely to remain a vital factor in economic development. Australian economic life has been much enriched by men of diverse nationalities endowed with varied skills and aptitudes, and in reviewing recent British experience he remarks of science that in no department of human activity is it truer to say that protective barriers are a cause of impoverishment and that their removal will always redound to the benefit of the community as a whole.

Dealing specifically with Great Britain, Mr. J. Isaac quotes some examples of the wide range of scientific activities which have been influenced by alien immigrants since 1933. Of 533 Fellows of the Royal Society, twenty-one went to Britain as refugees from the Continent of Europe, and many chairs at British universities are held by such immigrants; they have participated in such achievements as the British contribution to the development of nuclear energy, and a particularly noteworthy example is that of Prof. H. A. Krebs and Prof. E. B. Chain, who have shared the Nobel Prize for Medicine. As entrepreneurs and managers, pre-war immigrants have made notable contributions, introducing new ideas or specializing in branches of trade neglected in Britain, and their contribution in the Welsh Development Area in particular has received high praise in Parliament. The contribution of immigrants to the relief of Britain's post-war man-power problems has been limited by the qualified support given by British trade unions, the low standards of medical fitness, education or intelligence used for the selection of the workers, and by difficulties in finding accommodation in Britain for other members of the worker's family. Discussing the demographic aspect, Mr. Isaac points out that it would be a fallacy to assume that Britain could absorb a constant inflow of large numbers of immigrants in the future with similar favourable results, even if suitable persons were available, unless the immigrants could show that they have a special contribution to make.

In a concluding chapter, Mr. Oscar Handlin reviews generally the contributions of immigrants, particularly with reference to the depth of their influence on the host cultures and the extent to which those contributions were determined by the social conditions the immigrants encountered or by the character of the immigrants themselves. Finally, he concludes that, in a larger perspective, immigration establishes a complex of human ties and linkages that play a significant part in extending international understanding.

UNIVERSITY COURSES IN THE U.S.S.R.

ON September 1, 1955, new syllabuses came into force for first-, second- and third-year students of all university faculties in the U.S.S.R. These have been described by M. G. Uroyev, of the Central Board of Universities and Institutes of Law and of Economics.

Fourth- and fifth-year students continue to follow the old courses; but there is an important addition for students in the faculties of philology, history, physics and mathematics, biology, chemistry and geography. In their seventh term they will take a course on teaching methods and, in their eighth term, will do teaching practice in schools for six weeks; during this time they will have no lectures or other work.

For a number of subjects one of the main weaknesses of the old syllabuses was that they produced specialists of too narrow a type. One of the chief demands of the new syllabuses is that they should provide conditions suitable for the training of 'broad' specialists—people with a command of the fundamentals of the sciences but with a proper preparation for work in various branches of industry and culture.

Subjects of general scientific and technical importance are given more weight in the syllabuses; for closely related degree subjects within the faculties of biology, geology, philology and geography there will be unification of the general theoretical grounding given to all students. For the first two or three years students taking kindred subjects will follow exactly the same courses, covering the same ground and devoting the same amount of time to various courses. For example, for the six different degree courses which can be taken in geology, there are twenty-seven courses which are the same for all students. These take up to 66–68 per cent of the total time of the syllabus, leaving 32–34 per cent of their time for special subject courses.

The new syllabuses provide for broader subject divisions than the old and do not, as a rule, allow for specialization within the chosen subject. Such excessively specialized degree subjects as, for example, 'the editing of literary and political writings', 'the economics of the countries of the non-Soviet East', 'world economics', 'the history of international relations', 'Darwinism and genetics' have been discarded. Inorganic chemistry, organic chemistry and analytical chemistry, which used to be independent degree subjects, have now become subjects in which one specializes inside the framework of a general chemistry degree.

The number of hours available for faculty courses and seminars has been reduced. Universities now have the right to decide for themselves the subjects and extent of faculty courses and seminars, and to discuss and approve for themselves the advance plans produced for such courses. In this way such courses and seminars will reflect the scientific work being done in the given university.

In the case of students in the faculty of biology, the reduction in the amount of time allowed for their faculty courses and seminars has made it possible to increase the time devoted to learning a foreign language, to studying teaching methods of their subject, and to physics, chemistry and botany and higher mathematics.

The importance of the independent work done by students is recognized and reflected in the new syllabuses in the following way: the number of lectures and classes at which attendance each week is obligatory has been cut down; certain classes, in which the material dealt with can well be mastered by the student independently, have been done away with altogether; and the number of pieces of independent work required from the student in different courses has been increased.

The increase in the time given to teachers' training is of major significance; the main task now is to train teachers for the senior classes of the secondary schools. As from 1956, not less than 80 per cent of each year's graduates in the faculties of philology, history, geography and biology, and not less than 60 per cent from the faculties of chemistry and physics and mathematics, will be going to work as secondary school teachers.

The actual titles of the qualification received by graduate teachers has also been changed: the diploma given to a graduate used to read "qualified in history (or mathematics)" but will now read "qualified in history and as a teacher of history in secondary schools"*.

* *Translators' note.* The translators, who have carried out their task on behalf of the Society for Cultural Relations, write that the way in which Soviet and British university 'technical terms' have been equated in the translation is not consistent: Soviet graduates, for example, do not receive degrees, but diplomas. The word 'term' has been used for translating the Russian 'semestr', though this is really a half-year; but 'faculty' has been used in the Soviet way, although their faculties correspond to our schools or departments.

OVERSEAS FOOD CORPORATION

REPORT FOR 1954–55

THE annual report of the Overseas Food Corporation for the year ended March 31, 1955*, is the last report which the Corporation will publish, since the balance of funds made available for investigating the economics of mechanized and partly mechanized agriculture under tropical conditions has been transferred to the Colonial Development and Welfare Fund for the use of the newly established Tanganyika Agricultural Corporation, which will continue the investigations until September 1957 and report on them in due course. The legislation establishing the new Corporation provides also for the dissolution of the Overseas Food Corporation, and accordingly this final report is accompanied not only by the usual statement of accounts for the year but also by an interim review of the work of the whole undertaking from its inception. Some of the findings and conclusions merely confirm those of other workers in the Colonial Empire; but others are original, and the report should be of value to many concerned with the development of tropical agriculture both in East Africa and elsewhere. Moreover, it indicates the excellent work carried out not merely by the Scientific Department but also in land clearing and development. The African Tenant Farmers Scheme is developing satisfactorily in all three areas, and results have justified a continued extension of the Scheme. There is now every probability of consolidating one of the Corporation's original areas, Urambo, into an economic communal enterprise based on a flue-cured tobacco economy, and experience gained

* Overseas Food Corporation. Annual Report and Statement of Accounts for the Year ended 31st March, 1955. Pp. viii+183+8 plates. (London: H.M.S.O., 1955.) 6s. 6d. net.

in cattle-ranching in Kongwa indicates that the potentialities of that area for beef production are good.

The report thus indicates the real dividend that has accrued from the vast investment in the original Groundnut Scheme, and the chapter reviewing the scientific and experimental work over the whole period, which includes a list of published papers as well as an outline of present and future lines of research, should be of some general scientific interest. The areas in which the work has been done represent vast tracts of Africa which, if they could be opened up and economically developed, would play a major part in the development of those territories. Since the revised agricultural plan was introduced in 1951, the Corporation has had to dispense with the services of more than 1,100 Europeans and 14,700 Africans, most of whom have found satisfactory employment elsewhere, almost three out of every four Europeans remaining in Africa.

Steady progress was made in the investigations during the year, and although it is yet too early to say which size of farm and method of farming will eventually prove to be the most economical, the farm with 1,000 acres under crop appears to have a distinct advantage over those having 1,500 and 2,000 acres under cultivation in allowing a higher degree of supervision, while a combination of annual and perennial crops should prove the safest and most remunerative in the long run. As a result of experience during the past four years and with the advice of the Empire Cotton Growing Corporation and the Department of Agriculture, Tanganyika, it has been decided to discontinue cotton in Nachingwea, chiefly owing to the incidence of red bollworm.

The scientific and experimental work carried out during the past five years or more has covered soils and soil fertility, agronomy, pests and diseases, the residual effect of fertilizers, nitrate accumulation, rainfall and weed control, chiefly with reference to groundnuts, soya, maize, sorghum, sunflower and cotton. It has been shown, for example, that, for the successful production of groundnuts and the harvesting of a good final population, early planting and harvesting at the correct time are of particular importance and much more important than cultural methods. Early experiments have shown the great value of seed dressings of the organic mercurial type for improving stands, two dressings based on an organic mercurial and on tetramethylthiuram proving consistently better than the others. Seed-bed losses were due chiefly to a wide range of fungi, mainly of the Phycomycetes group, while fungi of the *Aspergillus niger* van Tiegh. and variants were responsible for post-emergent losses. A serious threat to the production of groundnuts is rosette disease, a virus disease transmitted by the aphis, *Aphis craccivora* Koch, and it has been established that in the Nachingwea district a local variety, Asirya Mwitunde, showed field resistance to this disease; it is hoped that selection will further raise the general level of resistance of the variety. Rosette infection has also been reduced considerably by treating groundnut seed with the systemic insecticide 'Schradan'.

The success of crop production at Nachingwea depends fundamentally on the maintenance of soil fertility and especially of soil structure so that the rainfall percolates into the soil where it falls, thus preventing soil wash at times of heavy rainfall and holding the water where the plant can use it, particularly in seasons of low rainfall. Permanent experiments have been laid down to test the value of continued application of artificial fertilizers and of two- and three-year Rhodes grass leys; but a solution must be sought along the lines of a resting phase that will reconstitute drainage channels in the soil, and in soil-management methods such as ridging. Methods of stubble disposal may also be important in this context.

When the present work on producing uniform varieties of Katambli that are resistant to *Polysora* rust disease is complete, the prospect of producing good yields of maize and groundnuts appears to be reasonably high. To complete a basic rotation, a white sorghum with good resistance to central shoot fly, *Atherigona indica subfuscata*, is needed. The variety Dobbs shows appreciable resistance. Soya bean yields also require a great improvement or else other crops must be introduced to provide breaks between successive cereal crops since, if these form too high a proportion of a rotation, the danger of serious losses from *Striga* is high. Work to produce a suitable sorghum and on breeding and selecting higher-yielding varieties of soya has commenced, as well as on sunflower and castor bean.

A study on the economic usage of fertilizers is projected. Even on one soil yields vary from field to field, and the continued application of phosphate on some of the older fields may have improved their phosphate status. Groundnuts generally respond well and economically to 100 lb. of single superphosphate. Maize often responds well to 100 lb. of single phosphate and 100 lb. of ammonium sulphate under experimental conditions; but the economic value of the fertilizer under production conditions is doubtful, while the response of soya and sorghum to fertilizers is low and unlikely to be economic. Future work should accordingly be directed to assess the value of the fertilizer for rotations rather than for individual crops.

Soil types on the catena vary greatly, and full utilization of these would assist the maximum utilization of land; but to use the easily erodible types is a work of great magnitude. So far, erodible types that have been cleared have been laid down as cashew plantations, but their use as pasture in a system of cattle management designed to bring fertility uphill is worth considering. Research at Kongwa is now devoted to pasture studies, particularly of the effects on natural pasture of grazing at different seasons of the year and intensity of grazing. Other investigations include the improvement of pasture by planting various mixtures and numbers of plants, seed-rates with and without superphosphate, seed production, protection of sown seed against ants, and the selection of improved strains of a wide variety of grasses. A study of 'dry farming' demonstrated that benefits of dry farming can be achieved with a protective covering of a short-season shallow-rooted grass, and that weeds and self-established grasses extract as much water as do heavy crops of maize and sorghum.

Urambo is a typical area of miombo bush, and the clearing is surrounded with forest heavily infected with *Glossina morsitans*. Recommendations made by the East Africa Tsetse and Trypanosomiasis Research Organization for controlling sleeping sickness and the fly population have been adopted by the Corporation and modified as experience indicated; but an experiment in the elimination of fly population by air spraying indicated that the cost—£1,000 per square mile—is not warranted unless immigration

of further flies is impossible. Discriminative clearing has proved very successful around Tabora, and a plan has been adopted to eliminate breeding areas inside the barrier clearing, to strengthen the barrier clearing so that the bush inside is isolated, and to reduce the pressure on the outside of the barrier by discriminative clearing for two miles into the bush all around the area. The results should be apparent during the next two years. It is not anticipated that immigration will ever be completely prevented; but the danger can be substantially eliminated by the destruction of all habitat inside the barrier. If cattle are to be kept economically, cover in which 'immigrants' can live should be eliminated so far as possible from the bush around the grazing area. The present acreage of tobacco and consequent use of firewood for curing should ensure automatic clearing of most of the inside bush in future.

STERIC EFFECTS IN ANIONOTROPIC REARRANGEMENTS*

By Prof. E. A. BRAUDE, Dr. J. A. COLES, Dr. E. A. EVANS and Dr. C. J. TIMMONS

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THE concept of steric hindrance, as applied to the reactions of organic compounds, has undergone a great deal of elaboration in recent years. Two main types of phenomena may be distinguished, though they are necessarily interconnected: those which arise primarily from spatial resistance by the molecule undergoing change to the approach of the reagent ('kinetic' effects); and those which are due mainly to either an increase or a decrease in steric strain in going from the reactant to the product ('thermodynamic' effects). Steric effects of thermodynamic origin have been rather less fully studied than those of kinetic origin; yet the former should be more readily amenable to quantitative interpretation since the reactivity differences will, in general, bear a more direct relationship to the physical properties of the reactants or products. We have established such a correlation between the rates of formation and the electronic spectra of certain conjugated systems, and since the principles involved should be of general applicability, a summary is presented here.

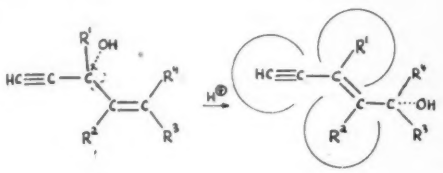
The reactions concerned are acid-catalysed anionotropic rearrangements of the type X—C(OH)—C≡C → X—C=C—C(OH), where X is an acetylenic, ethylenic or phenyl group. Previous studies have shown[1] that, under the usual conditions, these rearrangements proceed via the corresponding oxonium ions as indicated below, and are normally facilitated by electron-donating substituents, such as methyl, as would be expected for a reaction involving preliminary addition of a proton. The present data cover a range of reaction-rates of more than 10^{10}, and show that the differences of rate are largely due to changes in the energies of activation.

When X is C≡CH, the accelerating influence of methyl substituents is apparent at each of the positions R^1, R^2, R^3 and R^4, and the effects of several substituents when expressed as the decrease in energy of activation ($-\Delta E_A$) are approximately additive (Table 1). No steric hindrance in the resulting conjugated vinylacetylene system is indicated by scale projections, even in the highly substituted derivatives, and this is borne out by the fact that the characteristic electronic spectra of the products show only minor differences in this series.

Table 1. Rearrangements of Alkenylethynylcarbinols (I) → (II)

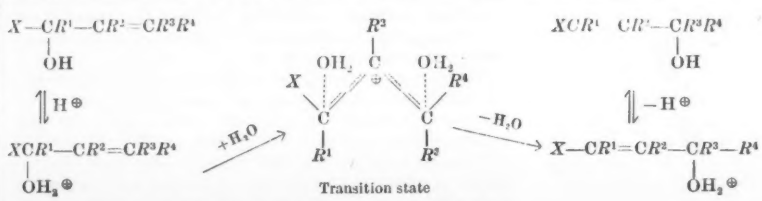
R^1	R^2	R^3	R^4	k'	ΔE_A	$\Delta\Delta E_A$	$\lambda_{max.}$	ε
H	H	H	H	0·00001	—	—	2230	13,500
Me	H	H	H	0·0002	−1·8	0·0	2235	13,500
H	Me	H	H	0·00005	−1·0	0·0	2230	13,500
H	H	Me	H	0·0006	−2·5	0·0	2235	13,500
H	H	Me	Me	0·13	−5·7	0·0	2240	13,000
Me	H	Me	H	0·09	−5·5	−1·2	2235	13,000
Me	H	Me	Me	4·0	−7·7	−0·2	2240	12,500

In this and the following tables, k' are the specific first-order rate-constants (min.$^{-1}$) in 60 per cent aqueous dioxan-hydrogen chloride at 30°, and $\lambda_{max.}$ and ε are the wave-lengths (in A.) and molecular extinction coefficients of maximal near ultra-violet absorption of the rearrangement products. For the meaning of other symbols, see text; ΔE and $\Delta\Delta E$ values are in k.cal./mol.



(I) (II)

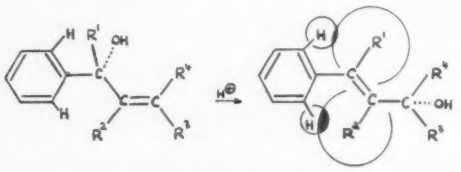
Quite a different situation is encountered when X is Ph (Table 2). Methyl substituents again cause an acceleration at R^3 or R^4; but at R^1 or R^2 they produce a decrease in rate and an increase in the energy of activation, which can be expressed as the difference ($+\Delta\Delta E_A$) between the observed and the additive or calculated values. These retarding effects are evidently not electronic and may therefore be presumed to be steric; but they can scarcely be of kinetic origin



* Paper read at the XIVth International Congress of Pure and Applied Chemistry in Zurich on July 22, 1955.

Table 2. Rearrangements of Alkenylphenylcarbinols (III) → (IV)

R^1	R^2	R^3	R^4	k'	$\Delta\Delta E_A$	$\Delta\Delta E_A$	$\lambda_{max.}$	ε	$\theta°$	$\Delta\Delta E_R$	$\frac{\Delta\Delta E_A}{\Delta\Delta E_R}$
H	H	H	H	0·0038	—	—	2510	19,500	0	0·0	—
Me	H	H	H	0·0027	+0·2	+2·0	2490	16,000	25	−1·3	1·5
H	Me	H	H	0·00024	+1·7	+2·7	2440	13,000	35	−2·4	1·1
H	H	Me	H	1·74	−3·7	0·0	2510	19,500	0	0·0	—
H	H	Me	Me	80	−6·0	0·0	2510	18,500	10	−0·3	—
Me	H	Me	Me	7·8	−4·6	+3·2	2480	10,000	44	−3·4	0·9
H	Me	Me	Me	3·0	−4·0	+3·0	2460	7,000	53	−4·5	0·7
Me	Me	Me	Me	9·8	−4·7	+4·1	2440	8,000	50	−4·1	1·0



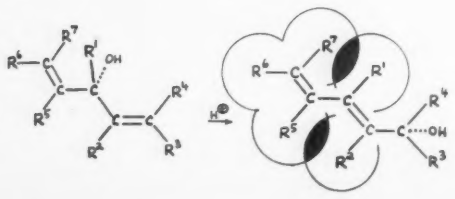
(III) (IV)

since substituents at R^1 or R^2 will cause no appreciable hindrance either to the attachment of a proton to the hydroxyl group, or to the approach of a solvent molecule to the carbon atom bearing R^3 and R^4. The scale projections indicate, however, that methyl substituents at R^1 and R^2 will prevent the styrene system formed in the reaction from taking up a uniplanar conformation owing to interference with the *o*-hydrogen atoms of the phenyl group; they also show that interference will be less severe for a substituent at R^1 than at R^2. Now, non-planarity is well known to decrease the resonance energy associated with a conjugated system and will therefore raise the energy-level of the products with respect to the reactants, that is, reduce the resonance energy gain ($+\Delta E_R$) accompanying the rearrangement. Further, since conjugation already becomes partially effective in the intermediate stages of the act of isomerization, non-planarity will also raise the energy-level of the transition state, that is, increase the energy of activation. Thus, the retarding influence of methyl substituents at R^1 and R^2 clearly represents an example of 'thermodynamic' steric effects.

The non-planarity of the hindered styrene derivatives is reflected in their electronic spectra. In each case where the formation of the conjugated system is sterically retarded, the rearrangement product exhibits a maximum at the usual wave-length, but of reduced intensity (Table 2); and the greater the retardation, the larger the drop in the absorption coefficient (ε). It has recently been shown[2] that such spectral effects permit the calculation of the mean interplanar angle θ in the ground-state by the simple relation $\varepsilon/\varepsilon^0 = \cos^2\theta$, where ε^0 is the absorption coefficient for the unhindered parent system. If we make the assumption that the dependence of resonance energy on interplanar angle obeys a similar relation $E_R/E_R{}^0 = \cos^2\theta$ ($\cos^1$ to $\cos^6$ functions have been advocated; but the $\cos^2$ function is the simplest which passes through the fixed points when θ is 0, 90° and 180°), we can deduce from the spectral data the *loss* in resonance energy gain ($-\Delta\Delta E_R$) due to steric hindrance. A comparison of these values with the increase in activation energy ($+\Delta\Delta E_A$) derived from the rate-measurements will provide a direct measure of the relative importance of resonance in the transition state and in the final product. The ratios ($+\Delta\Delta E_A/-\Delta\Delta E_R$) found are approximately constant and not far from unity, indicating that resonance stabilization is about equal in the transition states and in the products. This conclusion is in accord with the mechanism shown above, the transition state of which is essentially a strongly solvated carbonium ion. The extra resonance energy of such an entity would be expected to be intermediate between that of the corresponding semi-conjugated neutral system (about $\frac{1}{2}\Delta E_R$) and that of the corresponding free charge-resonance system[3,4] (about $2\Delta E_R$), that is, close to that of the neutral conjugated system (ΔE_R). The actual values of

Table 3. Rearrangements of Di-alkenylcarbinols (V) → (VI)

R^1	R^2	R^3	R^4	R^5	R^6	R^7	k'	$\Delta\Delta E_A$	$\Delta\Delta E_A$	$\lambda_{max.}$	ε	θ	$\Delta\Delta E_R$	$\frac{\Delta\Delta E_A}{\Delta\Delta E_R}$
H	H	H	H	H	H	H	0·0018	—	—	2230	25,000	0	—	—
H	Me	H	H	H	H	H	0·0033	−0·4	+0·6	2250	22,000	23	−0·7	0·9
H	H	Me	H	H	H	H	1·75	−4·2	0·0	2230	26,000	0	—	—
H	H	Me	Me	H	H	H	145	−6·8	0·0	2230	26,000	0	—	—
Me	H	Me	H	H	H	H	22	−5·7	+0·3	2280	20,000	28	−1·2	0·3
H	Me	Me	Me	H	H	H	132	−6·7	+1·1	2340	17,000	36	−1·8	0·6
H	H	H	Me	H	Me	H	184	−6·9	0·0	2270	26,000	0	—	—
H	H	Me	Me	H	Me	H	12,100	−9·4	+0·1	2270	26,000	0	—	—
Me	H	Me	Me	H	Me	H	3,700	−8·8	+2·5	2280	13,000	45	−2·5	1·0
H	Me	Me	Me	H	Me	H	6,400	−9·1	+1·4	2380	15,000	40	−2·1	0·7
H	H	Me	Me	H	Me	Me	300,000	−11·4	0·0	2370	26,000	0	—	—
Me	H	Me	Me	H	Me	Me	5,900	−9·0	+4·2	2280	8,000	56	−3·5	1·2
H	Me	Me	Me	Me	Me	Me	35	−5·9	+7·5	2280	5,000	64	−4·2	1·8



(V) (VI)

$\Delta\Delta E_A/\Delta\Delta E_R$ depend, of course, on ΔE_R, estimates of which vary considerably. We have chosen 7 k.cal. for the styrene system and 5 k.cal. for the butadiene system as reasonable figures.

Similar results have been obtained in the formation of the butadiene system by rearrangement of diethylenic alcohols[5] (Table 3). Once again, methyl substituents in the 'outer' positions R^3, R^4, R^6 and R^7 accelerate the isomerization, while those in the 'inner' positions R^1, R^2 and R^5 retard it. As before, retardation goes together with non-planarity of the conjugated system formed, as indicated by scale

projections and by the decrease in intensity of the characteristic bands in the electronic spectra. With methyl substituents at either R^1 or R^2, but not simultaneously at R^7 or R^5, the steric retardations are relatively small ($+\Delta\Delta E_A < 2$ k.cal./mol.), since only methyl-hydrogen interference will occur. On the other hand, with methyl substituents at R^1 or R^2 and simultaneously at R^7 or R^5, as in the last two examples in Table 3, the steric retardations are large ($+\Delta\Delta E_A > 4$ k.cal./mol.), since in these cases interference between two methyl groups is involved. The $(+\Delta\Delta E_A/-\Delta\Delta E_R)$ ratios, though of the same order, are more variable in this series and the differences can be interpreted; but their limited accuracy does not in our opinion justify carrying the analysis further at present. The estimated or observed values of $(+\Delta\Delta E_A/-\Delta\Delta E_R)$ could obviously be used, however, to calculate the relative rates of formation of other hindered conjugated systems from their electronic spectra, or *vice versa*.

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SPIRACULAR CONTROL OF DISCONTINUOUS RESPIRATION IN INSECTS

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THE respiration of many groups of insects is remarkable in that metabolic carbon dioxide is retained within the insect and released during brief periods in 'bursts'[1]. In diapause pupæ of the Cecropia silkworm, *Platysamia cecropia*, more than nine-tenths of the metabolic carbon dioxide is stored and then released in brief bursts which occur from once every week to many times per hour, depending on the temperature and metabolic rate. The remaining carbon dioxide escapes during the interburst period. The uptake of oxygen, unlike the release of carbon dioxide, is continuous and steady. If the spiracles are sealed with paraffin, virtually all the respiratory exchange ceases; the spiracles are, therefore, the site of both the discontinuous release of carbon dioxide and the simultaneous continuous uptake of oxygen[2].

Since oxygen uptake is continuous, the spiracles must remain partially open between bursts, permitting oxygen to diffuse in. Thus we are confronted with two perplexing facts; namely, that oxygen enters the insect during the interburst period at many times the rate at which carbon dioxide leaves, and that the insect releases its carbon dioxide periodically. The latter is the simpler to explain and is considered here.

The fact that the spiracles are partly open between bursts has led some to conclude that the opening and closing of the spiracles cannot be responsible for the discontinuous release of carbon dioxide[3]. During the past two years, however, we have obtained considerable evidence that the cycle of retention and release of carbon dioxide does indeed result from the cyclical activity of the spiracles. The aperture of each spiracle is regulated by a spiracular valve served by a closer-muscle. When this muscle relaxes, the valve opens because of its own elasticity and because of the tension of an elastic ligament which opposes the closer-muscle. The muscle receives nerve fibres from the corresponding segmental ganglion and from the median nerve of the previous segment[4].

The central importance of the spiracular valves in the discontinuous release of carbon dioxide was suggested by the observation of Buck *et al.* that intubating the spiracles of *Agapema* pupæ eliminated the bursts of carbon dioxide[5]. Similarly, we observed that excision of the valve from one of the fourteen functional spiracles of a *Platysamia* pupa caused carbon dioxide output to become continuous. Lowering the metabolic rate of these surgically treated pupæ by keeping them at 10° C. did not cause the bursts to reappear. Indeed, the only manœuvre that restored the discontinuous release of carbon dioxide was the sealing of the open spiracle. It appears from this experiment that all the spiracles remain nearly closed during the interburst, preventing carbon dioxide from diffusing out in substantial quantities, and that one or more of the spiracles opens during a burst. The spiracular valves are thus the key to the discontinuous release of carbon dioxide.

The activity of the valves in the living pupal silkworm was recorded by following the leading edge of a valve with the hairline of an ocular micrometer, the movements of which were translated into a kymograph trace by a system of pulleys and levers. Fig. 1 is a portion of a typical record of the activity of an abdominal spiracle of a *Platysamia* pupa. The ordinate of the trace shows the width of valve-opening in arbitrary units, while the abscissa denotes the duration of the opening. A consistent pattern of valve movement occurred in cycles lasting 45 min. to 2 hr. After a period during which it remained closed and motionless, the valve fluttered for about 15 min., and then, within a minute, the valve movements progressively increased in amplitude until the valve opened fully. Swaying slightly, it remained open for several minutes. Then it alternately opened and closed for several minutes, and the valve movements gradually decreased in amplitude and duration until the valve closed altogether. Following this, the valve remained motionless until the fluttering preceding the next period of wide openings. This cycle was repeated over and over and apparently represented the normal behaviour of the spiracle. Manometric observations of the carbon dioxide output of this pupa revealed bursts of carbon dioxide at intervals of 30 min. to 2 hr. A similar correlation between the frequency of carbon dioxide bursts and periods when the valve was widely opened has been consistently observed in all other silkworm pupæ studied. It is evident that the periodic release of carbon dioxide by the insect results from a periodical prolonged opening of the spiracles which I term a 'burst'. Moreover, it appears that the continuous interburst

inflow of oxygen and outflow of carbon dioxide is not the result of occasional small openings of valves between bursts. Rather, oxygen enters and a trace of carbon dioxide leaves through the very small opening which must persist after the valve closes.

Variations in the ambient tensions of oxygen and carbon dioxide exert a profound effect on this cycle of valve activity (Fig. 2). Increasing the oxygen tension above the 21 per cent in air progressively eliminated the interburst fluttering but left the burst-frequency unaltered. Decreasing the oxygen tension below 21 per cent progressively increased the interburst fluttering until, at tensions below 15 per cent, the bursts disappeared and the valve fluttered continuously. Finally, when the oxygen tension fell to about 5 per cent, the valve remained wide open, closing only intermittently. As carbon dioxide tension increased above 5–8 per cent, the frequency of bursts increased and the duration of the bursts lengthened. In 15 per cent carbon dioxide the valves fluttered continuously, and at still higher tensions of carbon dioxide they behaved as they did in 5 per cent oxygen.

These findings explain the previous manometric findings that increasing ambient oxygen tension decreased the interburst output of carbon dioxide, that increasing the carbon dioxide tension above 5–8 per cent increased the frequency of carbon dioxide bursts, and that low tensions of oxygen and high tensions of carbon dioxide eliminated the discontinuous respiration[2]. Moreover, the observations suggest that within the insect the normal stimulus for cyclical valve activity is a combination of decreasing internal tension of oxygen and increasing internal tension of carbon dioxide during the interburst period. The following hypothesis is consistent with all the observations.

Immediately after a burst the valves are closed; but they leak sufficiently to permit some inflow of oxygen and outflow of carbon dioxide. The valve opening, however, is so small and the gradient driving oxygen in so slight that oxygen inflow does not match oxygen utilization, and the oxygen tension within the tracheal system of the insect falls. When the intratracheal oxygen tension falls to about 10 per cent, the spiracular muscle partially relaxes and the spiracle opens, permitting oxygen to enter. This increases the oxygen tension, and the valve promptly closes. This pattern of opening and closing is repeated and represents the period of fluttering prior to a burst. During the interburst period some carbon dioxide escapes, but at a rate less than that of its production. The internal carbon dioxide tension ultimately reaches a critical threshold and the closer-muscle relaxes, the valve opens widely in a burst, carbon dioxide pours out and oxygen flows in. As the internal carbon dioxide tension now decreases and the internal oxygen tension increases, the valve begins to close and open periodically with diminishing width and duration of opening until finally it remains closed and the cycle is completed.

Further support for this hypothesis comes from the following observations on animals with intubated spiracles. A series of pupæ had tiny glass tubes inserted in several of their spiracles beyond the spiracular valves, placing their tracheal system in free communion with the air. The carbon dioxide tension within the insect fell and the oxygen tension rose as the gas tensions within the insect approached that of the outside. In such pupæ, the unintubated spiracular valves remained tightly closed for many days, presumably because the normal stimuli triggering spiracular activity were absent. The spiracles opened, however, when the ambient oxygen tension was reduced below about 10 per cent or the carbon dioxide tension raised above about 10 per cent. Further, we noted that the threshold concentration of carbon dioxide needed to trigger the opening of the spiracles diminished as the oxygen tension was decreased below 21 per cent[4].

Having established a possible sequence of events to account for the cyclical activity of the spiracles, we come to the question of the co-ordination of this activity and the location of the chemoreceptors sensitive to changes in gas tension. Although a localized stream of carbon dioxide could cause individual spiracles to open, in the normal insect the spiracular valves were co-ordinated. When the valves opened in a burst or closed at the end of one, they did so within a minute of each other, though when they fluttered the pulsations were not in exact synchrony. Moreover, in an intubated pupa the carbon dioxide and oxygen thresholds for spiracle opening were very similar in the several spiracles of an individual. There is, however, no indispensable central respiratory centre for all the spiracles;

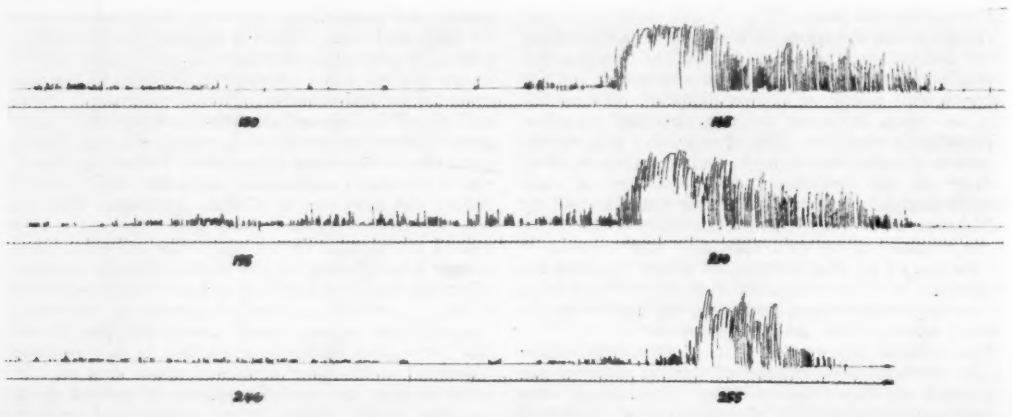

Fig. 1. Portion of a typical record of the valve movements of the third abdominal spiracle of a *Platysamia* pupa in diapause at 25° C.

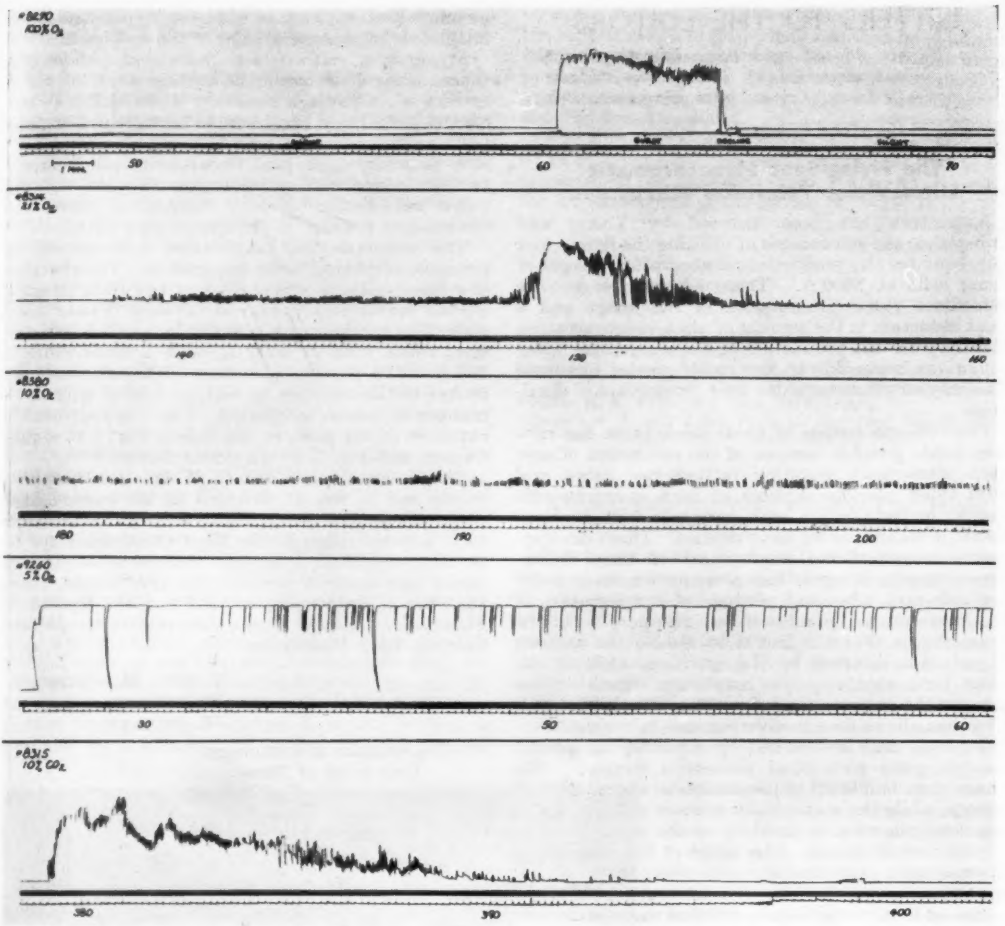

Fig. 2. Records of spiracular movements in various ambient gas tensions. In all cases except 5 per cent oxygen, records were made when spiracular activity had reached a steady state. In the case of 5 per cent oxygen, exposure to the gas began about one minute prior to the recorded opening

isolated pupal abdomens, isolated anterior fragments and pupæ with all abdominal or all thoracic and cephalic ganglia removed still released their carbon dioxide discontinuously[7]. From this last result one could confidently predict that denervated spiracles would remain closed; otherwise the bursts would have disappeared. This was borne out by observing the spiracles of pupæ with one or more segmental ganglia removed: the spiracles serving the denervated segments remained closed in air. They opened in low oxygen tension or high carbon dioxide tension but were somewhat less sensitive than innervated spiracles of the same individual[8]. The response persisted for at least forty-two days after denervation. The stimulus for contraction of the closer-muscle of the spiracle after it was deprived of all central nervous connexions remains for the present a mystery. Efforts to demonstrate a peripheral ganglion near the muscle have thus far met with failure. Further histological as well as pharmacological studies of the spiracular mechanism are under way in an effort to clarify this issue. Present evidence points to a peripheral sensory mechanism and a peripheral motor mechanism, the latter facilitated by the central nervous system.

I wish to thank Mr. Rishon Stember and Miss Diana Veit, who undertook many of the recordings of spiracular movement, and Dr. W. E. Beckel, whose detailed anatomical description of the spiracle was vital to the work reported. This investigation has been supported by Grant *H*-1887 from the National Heart Institute of the U.S. Public Health Service and the Sage and Sackett Funds of the Zoology Department of Cornell University.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Flying-Spot Monochromatic Ultra-Violet Television Microscope

Attention has been directed by Young and Roberts[1] to the advantages of utilizing the flying-spot technique for the production of absorption images of living cells at 2600 A. These advantages are the immediate visual presentation of the image and a great reduction in the amount of ultra-violet radiation necessary for the production of the image, the latter advantage being due to the much greater quantum efficiency of photocathodes over photographic emulsions.

Practical realization of these advantages has now been made possible because of the utilization of new deep ultra-violet scanning cathode-ray tubes and ultra-violet photomultipliers of high quantum efficiency, in conjunction with certain recent developments in technique we have devised. These developments consist of the employment of 4-sec. frame-sweep speeds, 60-cycle line presentation on a radar (cathode-ray) tube, and photographic integration of the image on the monitor tube. The purpose of the 4-sec. frame, 60-cycle line is to reduce the amount of radiation received by the specimen while at the same time obtaining the maximum signal-to-noise ratio on the presentation tube; photographic integration then allows for a further increase in the signal-to-noise ratio and is obtained by exposing the photographic plate to several successive frames. The image then builds up in proportion to the number of frames, while the statistically random distribution of the noise allows it to build up as the square root of the number of frames. The limits of this integration process are: (*a*) the signal-to-noise ratio of the specimen image on the monitor tube should be sufficient to allow for ease in focusing the microscope; (*b*) the total integration time should be short when compared to particle movement within the living cell; in the case of mitosis this would perhaps be of the order of one minute or less. In the observation of non-living material (*b*) does not apply, and integration may be virtually infinite. Improved ultra-violet scanner tubes are in the process of construction which will provide a greatly improved signal-to-noise ratio; the necessity of photographic integration will be minimized and may be obviated, dependent on the image-forming characteristics of the specimen.

Flying-spot ultra-violet television microscopy should show considerable advantage over television-camera ultra-violet microscopy since the television camera tube has a considerable background of noise, not due to statistical arrival of photons; and the lack of really high gain between its photocathode and the associated amplifier means that the first valve contributes noise. Neither of these disadvantages applies to photomultiplier tubes.

The accompanying illustrations demonstrate the principle of photographic integration. The specimen is a tissue-culture preparation of the Hela strain of human cancer cells, mounted between 'Vycor' cover slips. The specimen was scanned by a monochromatic ultra-violet spot at 2600 A. with a band-width of 100 A. The photographs show identical absorption images of the same living cells, and differ only in the number of frames integrated. Fig. 1 is the result of exposure of the plate to one frame, Fig. 2 to sixteen frames, and Fig. 3 to sixty-four frames.

Thanks are due to Mrs. O. Walker for the photographs and to Mrs. D. Robbins for the tissue culture preparations; to the E.M.I. Research Laboratories, Ltd., and the Allen B. Du Mont Corporation for the development of the flying-spot scanner tubes. Grants-in-aid were made by private citizens of Dallas, Texas, the Damon Runyon Memorial Fund, the Rockefeller Foundation, and the Texas Instruments–Geophysical Service, Inc., Foundation.

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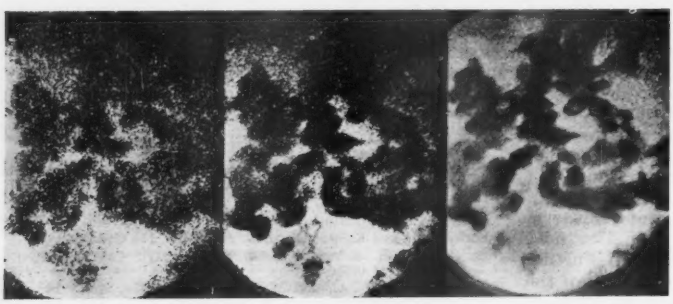

(1) One 4-sec. frame. (2) Four 4-sec. frames. (3) Sixteen 4-sec. frames. Monochromatic ultra-violet absorption images of living Hela cells at 2600 A., bandwidth 100 A.

Micro-analysis by a Flying-Spot X-Ray Method

The point-by-point investigation of a surface by analysis of the characteristic X-ray line emission has been initiated by Castaing[1]. He obtained an electron spot of the order of 1 micron in diameter with an electrostatic lens system and moved the specimen under the fixed spot; the point examined was identified by means of an optical viewing system. Analysis is greatly facilitated if the electron spot is scanned across the specimen and if a counter is used for collecting part of the emitted X-rays. The signal from it can be transferred to a cathode-ray tube scanned in synchronism, so that a picture is displayed of the part of the surface under investigation. Such a system is similar to the electron scanning microscope[2]. It differs appreciably from that proposed by Pattee[3], in which an electron spot scans a thin target of a pure metal next to which is placed the specimen to be examined, so that image con-

trast is due not to emission but to differential absorption, as in the normal form of X-ray projection microscope[4].

We have built and operated successfully a flying-spot X-ray microscope of the emission type. Magnetic lenses have been used, so as to obtain a smaller electron spot or alternatively a greater beam current in a spot of the same size, as compared with electrostatic lenses. By employing a proportional counter, a particular X-ray line can be selected as the imaging signal, so that in the picture only those parts of the surface appear bright which contain a given element. Fig. 1,*A*, *B*, *C*, *D* shows the degree of differentiation obtained from an impure sample of beryllium. Fig. 1,*A* is obtained when all quanta are recorded, and Fig. 1,*B*, *C*, *D* when those of certain energies only are passed by the pulse analyser. The magnification and contrast of the image can be controlled electronically and the area of specimen scanned may be varied at will. By stopping the electron probe over a selected point on the surface, the spectrum of X-rays emitted by it may be mapped by varying the band accepted by the pulse analyser. In this way the bright areas in Fig. 1,*B*, *C*, *D* were identified as manganese, nickel and calcium respectively.

In quantitative analysis the ability to discriminate one element from another is limited to approximately $\Delta Z \geqslant 4$; the natural width of a characteristic line is considerably broadened by the proportional counter. The accuracy can be greatly improved by using a simple crystal spectrometer for initial analysis of the X-rays. A new magnetic lens has been designed and constructed which allows this to be done through one exit port, while through a second port another portion of the X-rays emitted from the surface is accepted by a scintillation counter for the purpose of image formation. Direct quantitative results for the concentration of an element can thus be obtained; it will be possible to separate neighbouring elements in the periodic table. The concentration sensitivity and accuracy of location are now the subject of detailed investigation.

We wish to thank Dr. W. C. Nixon and Mr. J. V. P. Long for many useful discussions and to the Department of Scientific and Industrial Research for a maintenance grant to one of us (P. D.).

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May 24.

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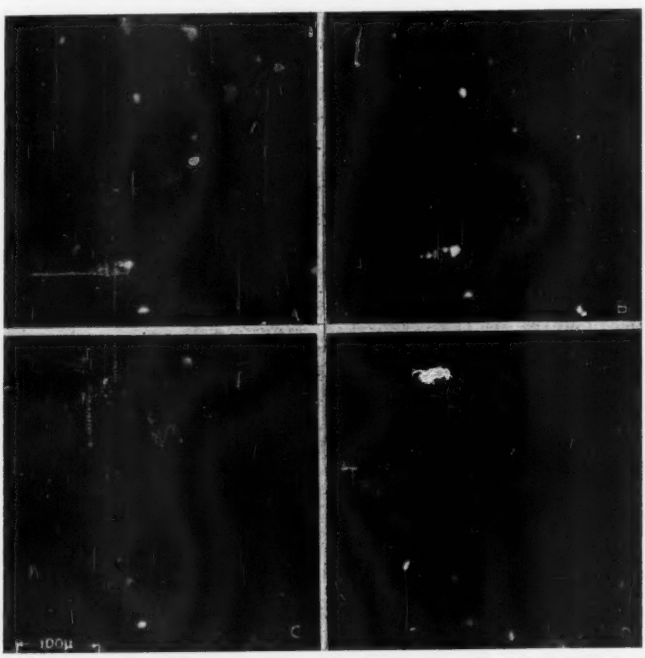

Fig. 1. X-ray emission micrograph of impurities in beryllium foil. × 130.
A: All constituents recorded. *B*, *C*, *D*: Characteristic emission from different impurities, separately selected—magnesium, nickel and calcium respectively

Cosmic-Ray Increase observed at High Southern Latitudes on February 23, 1956

The large, sudden increase in cosmic-ray intensity between the hours 0300 and 0400 G.M.T. on February 23 was observed at Hobart, Tasmania, Australia, and also at the Australian National Antarctic Research Expedition's bases at Macquarie Island and Mawson, Antarctica. At the same time radio fade-outs, ionospheric and magnetic disturbances were recorded. The cosmic-ray increase resembles those observed in other places on four previous occasions in association with solar flare activity, namely, on February 28 and March 7, 1942, July 25, 1946, and November 19, 1949 [1].

The increase was observed at the three stations with counter telescopes, and also with a 23-litre shielded ionization chamber at Hobart. The telescopes at Hobart and Mawson have 1-metre square counter trays, the extreme tray separation being 1·5 m. At each of these stations there are two telescopes, one of which is operated vertically, the other inclined at 45° to the zenith. Each telescope contains 10 cm. of lead absorber. At Macquarie Island there is a small vertical array of four 20 cm. × 20 cm. counter trays equally spaced by 15 cm. with 10 cm. of lead between trays 2 and 3, and also between trays 3 and 4, numbering from the top tray. The trays were connected to two three-fold coincidence circuits in such a way that the intensity of particles able to pass through 10 cm. or alternatively 20 cm. of lead is recorded separately.

The time of commencement of the cosmic-ray increase observed with the ionization chamber was 0341 G.M.T., the maximum possible error of timing being estimated at ± 2 min. The rate of increase of ionization was very high, and the commencement time given above

Table 1

Station	Lower limits of percentage increase above the mean for 6 hr.			
	Ion chamber 10 cm. lead	Vertical tel. 10 cm. lead	Inclined tel. 10 cm. lead	Differential tel. 10 cm. but not 20 cm. lead
Hobart (Geomag. co-ord. 52° S., 224° E.)	135	169	67 (East)	
Macquarie Island (61° S., 243° E.)		139		360
Mawson (73° S., 103° E.)		175	185 (West)	

Cosmic ray increase commenced at Hobart at 0341 G.M.T. ± 2 min. Duration about 4 hr.
Radio fade-out observed at Sydney, 0332–0444 G.M.T.
Solar radio noise on 85 Mc./sec. observed at Sydney, 0335 G.M.T. End not observed.
Solar radio noise on 19 Mc./sec. observed at Sydney, 0335 G.M.T. Ended at 0406 G.M.T.
Information supplied by the Radiophysics Division, Commonwealth Scientific and Industrial Research Organization, Sydney.
Radio fade-out began at Mawson, 0342 G.M.T.
Magnetic disturbance at Macquarie Island began 0333 G.M.T. Duration about 2 hr.

is the instant at which the intensity departed from the normal level by an amount equal to the 95 per cent confidence limit. The peak intensity was not observed, as the recorder went off-scale.

Recording intervals of 1 hr. were in use with the telescopes at the time of the increase, so that the peak intensities were not observed. However, by assuming that the time of commencement of the increase was the same at each recorder, it is possible to calculate the lower limits for the peak intensities. These and other relevant details are set out in Table 1.

The following comments may be made concerning the observations:

(1) The cosmic-ray increase began within a very few minutes of the accompanying radio fade-outs and the arrival of ultra high-frequency solar radio bursts at the Earth. Also, the duration of the increase was of the same order as that of the fade-outs and bursts. This suggests that on this occasion the acceleration of the particles took place on the Sun at practically the same time as the enhanced ultra-violet and radio emission. If this is so, consideration of the time of flight of the particles leads to the conclusion that the path-length cannot have been more than $1\frac{1}{2}$ times the Sun–Earth distance. This is consistent with a very weak general solar magnetic field.

(2) The effect was more pronounced at low particle-energy, as shown by the large percentage increase in the low-momentum band (235–340 MeV./c for μ-mesons) detected at Macquarie Island. This is also supported by the results from the inclined telescopes, bearing in mind that the most favoured direction of approach for positive particles of low energy is from the west.

(3) No cosmic-ray decrease was observed in association with the magnetic storm which occurred on February 25. In this respect the flare effect was similar to those of March 1942 and November 1949, but differed from those of February 1942 and July 1946.

(4) The increases observed at Macquarie Island and Mawson, and possibly those at Hobart, are not consistent with the impact zones predicted using a simple dipole field[2]. Assuming that a particle must have a rigidity greater than 3 BV. to produce a meson component at sea-level, and that the solar source is 25° in diameter, the background zone cannot extend beyond lat. 51° S. Particles of rigidity greater than 3 BV. may reach higher latitudes than this in localized impact zones; but none of the stations is in such a zone. The departure from simple theory is not unexpected, as increases were observed at high northern latitudes on the four previous occasions.

(5) After correction for atmospheric pressure, the intensity at each station for a few days prior to the increase was about 2 per cent less than normal, and after the increase returned to the depressed level for a period of a few days. If this decrease is to be interpreted as a screening effect produced by magnetized gas clouds[3], it might explain qualitatively the discrepancy between the observed increases and the predicted impact zones. The magnetic disturbance observed at Macquarie Island is a further indication that complicating agencies were present at the time.

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Effect of Shape on the Static and Dynamic Stress–Strain Relationship of Bonded Rubber in Compression

The stress–strain relationship of rubber under unidirectional compression with free expansions in the other two directions has been derived from the kinetic theory of rubber-like elasticity by Treloar[1] and others. These conditions can be simulated by compressing the rubber between parallel plates at which friction is eliminated by lubrication. The static compressive stress σ_s (lb./in.^{2}) is given by

$$\sigma_s = G_s(\lambda - \lambda^{-2}) \qquad (1)$$

where G_s is the static shear modulus and λ the ratio of compressed to initial height. This relationship holds true provided the lubrication is adequate. Where free lateral expansion is prevented by friction or bonding at the confining surfaces, the shape of the rubber influences the stress–strain relationships in a way that has hitherto defied systematic analysis. Kimmich[2] showed that most of the difficulty in correlating published results may be explained by the nature of the surface of the compressing plates and of the rubber, the manner of applying the stress, the thixotropic behaviour of some rubbers, and because the stress–strain relationship is not linear. As the industrial uses of rubber in compression (usually with the faces bonded to metal) are very numerous, a mathematical relation between stress

and strain is essential for design purposes. It is the purpose of this communication to point out a general relationship obtained from experimental results for rubber specimens of various sizes bonded to metal plates.

From a critical discussion of the literature on shape effects, it was concluded that the static stress–strain curve of a bonded rubber can be described by

$$\sigma_s = G_s \Phi \qquad (2)$$

where $\Phi = f(\lambda, \delta)$, δ being a shape factor related to the geometry of the rubber; for example, for cylinders δ is the radius/height ratio. The above expression separates the rubber property G_s from the purely geometrical term Φ. Any change in the properties of the rubber due to its nature, to speed of test, temperature and thixotropy are therefore reflected only in the G_s term.

The stress–strain curves for bonded rubber cylinders of various values were obtained using a pure gum natural rubber vulcanizate. The values for particular λ and δ were obtained from the stress–strain curves by dividing the stress by G_s, derived from the linear relationship (equation 1) between stress and $(\lambda - \lambda^{-2})$ for the rubber compressed between lubricated plates.

Fig. 1 shows that the plots of Φ against δ^2 are linear over the ranges of shape factor and precompression studied and conform to the equation:

$$\Phi = (\lambda - \lambda^{-2})(1 + K\delta^2) \qquad (3)$$

where $K = 0{\cdot}413$. Shape factor zero ($\delta = 0$) thus corresponds to a perfectly lubricated rubber, and a bonded rubber with $\delta > 0$ differs from this ideal case by the factor $(1 + K\delta^2)$. The constant K is similar to that proposed by Hattori and Takei[3] from classical theory for small finite strains. Similar expressions to the above but differing mainly in the coefficient K and definitions of δ have been obtained for other shapes, for example, squares and rectangles.

If now a sinusoidal dynamic strain of amplitude H is superimposed upon a static compression to a height λ_0, the total stress $\sigma_T(t)$ at any time t is

$$\sigma_T(t) = \sigma_s + \sigma_D(t) \qquad (4)$$

where σ_D is the instantaneous dynamic stress, given by

$$\sigma_D(t) = G_D \int_{\lambda_0}^{\lambda_0 + H\sin\omega t} (\mathrm{d}\Phi/\mathrm{d}\lambda)\mathrm{d}\lambda \qquad (5)$$

G_D being the fundamental dynamic shear modulus at the frequency of test.

The overall dynamic stress variation σ_0 over one cycle is

$$\sigma_0 = G_D \int_{\lambda_0 - H}^{\lambda_0 + H} (\mathrm{d}\Phi/\mathrm{d}\lambda)\mathrm{d}\lambda \qquad (6)$$

As Φ increases monotonically with λ, then (from equation 3):

$$\sigma_0 = G_D(1 + K\delta^2)(\lambda - \lambda^{-2})_{\lambda_0 - H}^{\lambda_0 + H} \qquad (7)$$

A typical experimental graph plotting values of σ_0, for precompressions from $\lambda = 1{\cdot}0$ to $0{\cdot}55$ and superimposed dynamic oscillations $H = \pm 0{\cdot}004$ to $\pm 0{\cdot}086$ against $(\lambda - \lambda^{-2})_{\lambda_0 - H}^{\lambda_0 + H}$, indicates that a linear relationship the slope of which is $G_D(1 + 0{\cdot}413\,\delta^2)$ fits the experimental points, G_D having been obtained from a similar set of dynamic tests using lubricated faces.

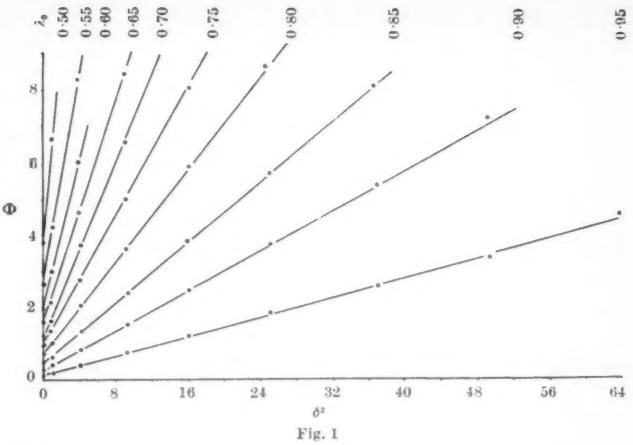

Fig. 1

The above relationships hold for the in-phase or elastic component of the complex dynamic modulus, and also for the out-of-phase or viscous components. These relationships have been applied to the published results on the static stress – strain curves of Kimmich[2], Hattori and Takei[3], and Schay and Ször[4], and for the dynamic results of De Meij and van Amerongen[5]. Without exception, the above relationships give an adequate description of the experimental results.

It is hoped to publish a fuller account of this work elsewhere, together with a further discussion using these relationships for various shapes and for various types of rubbers, including those which show marked thixotropic behaviour.

This work forms part of a research programme on the static and dynamic properties of rubber, and I thank the Council of the Research Association of British Rubber Manufacturers for permission to publish this communication.

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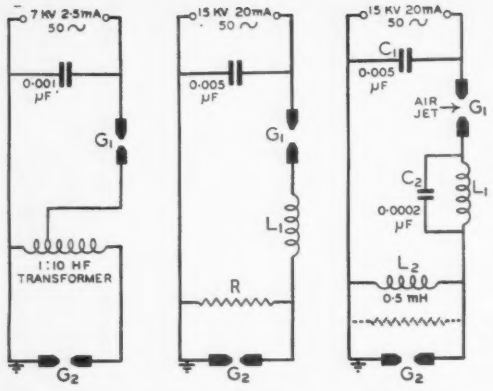
Absence of Shock Hazard with Certain Multigap Spark Circuits

I have found that the shock hazard associated with some electric spark generators is not so great as is generally believed and can be reduced to negligible proportions by appropriate design. Kaiser and Wallraff[1] and others have shown that spark-gap voltages are quite low (order of 50 V.) during discharge and that, in a twin-gap circuit similar to circuit 2, a high voltage appears across the gap G_2



Circuit 1 Circuit 2 Circuit 3

for only a fraction of a microsecond at the beginning of each discharge. Since it is known that the human body can tolerate high-voltage pulses of very short duration, a reasonable inference is that little or no shock should be felt on touching the electrodes of G_2, provided the gap continues to break down in normal fashion. Most people would be reluctant to put this to the test, and I have not seen any report of it having been done.

The experiments to be described were carried out with spark circuits of a type and power-level widely used in spectrographic analysis. In each of the circuits shown, G_1 represents the control gap determining the striking voltage, while G_2 represents the analysis gap which, for convenience in manipulation, is often unprotected by a cage.

Preliminary experiment with the safe low-energy discharge produced by circuit 1 showed that touching the electrodes of G_2 did not prevent a spark jumping the gap, at least up to 3 mm. length, and that no shock was felt. It was then practically certain that the same would hold with circuit 2, since the body currents incurred would be of the same order of magnitude and duration, though the spark currents would be much greater than with circuit 1. This was confirmed with a gap of 4 mm. at G_1, 2 mm. at G_2 and no added inductance at L_1, all electrodes being graphite. The resistance R was merely that provided by touching the electrode holders with two fingers of one hand, probably equivalent to 1,000–2,000 ohms[2]. Since the sparks produced by this circuit are highly energetic and noisy, the demonstration makes quite a spectacular display.

In later trials, however, it was found that when an inductance of 0·03 mH. was added at L_1, frequent shocks were received, even when G_2 was made very short. No improvement followed when an inductive bridge of 0·5 mH. was placed across G_2 for the purpose of by-passing any anomalous low-frequency current. After some exploration, the shocks were eventually attributed to the occurrence of misfires with some 'tailing' sparks, that is, weak sparks which follow soon after a previous spark during the period of incomplete de-ionization, when the breakdown voltage is much less than normal. Photographs showed that increasing the inductance of the discharge loop results in more frequent occurrence of tailing sparks, and de-ionization-rates appear to be so erratic that occasionally the breakdown potential of G_1 may be temporarily lower than that of G_2. Should a spark occur on such an occasion, G_2 will not fire. Blowing a 50 metre/sec. jet of air across G_1 after the manner of Enns and Wolfe[3] eliminated tailing sparks and shocks.

To ensure breakdown of G_2, a liberal excess of voltage should be provided; that is, in circuit 2, G_1 should be considerably longer than G_2. As L_1 is increased, the voltage available at G_2 is reduced (for example, when R is 1,000 ohms and L_1 is 1 mH., the calculated maximum voltage at G_2 is about 75 per cent of the initial voltage at G_1). If R be replaced by an inductance L_2, the maximum voltage at G_2 in an idealized circuit would be $L_2/(L_1+L_2)$ times the initial voltage at G_1. With both L_2 and R in parallel with G_2 the voltage would be still lower. Another consequence of increasing L_1 is that the time of rise of voltage at G_2 is lengthened, so that eventually a stage would be reached at which shocks would be possible because of the long delay in attaining the breakdown voltage at G_2. The limit in this respect was not determined. Both these dangers accompanying the increase of inductance L_1 can be overcome by placing in parallel with L_1 a small condenser C_2 as in circuit 3. For a brief period immediately after the breakdown of G_1, C_2 virtually short-circuits L_1, and thus, irrespective of the value of L_1, practically the whole of the initial voltage becomes available at G_2 with a very short time of rise. The characteristics of the succeeding discharge, for spectrochemical purposes at least, are only slightly affected by the presence of C_2, provided that C_2 is small compared with C_1.

A fuller account is to be given elsewhere of this work, and of the application of the series-gap device to removing the shock hazard from a spark-ignited arc source. In the arc circuit the isolating gap can be shorter than the exposed gap.

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Fatigue of Metals under Random Loads

The stresses produced in an aircraft structure during flight are of an irregular random nature, reflecting the characteristics of the source of the stresses, namely, atmospheric turbulence. It is often necessary to try to estimate the fatigue life of a structural member under these flight loads. Usually the only fatigue data available are from laboratory tests in which the applied stress is a constant-amplitude sine wave. Miner[1] has suggested a procedure by which, knowing the fatigue life at various sine-wave amplitudes, the fatigue life under a given irregular loading may be calculated.

Many tests of Miner's rule have been made with an applied stress which is sinusoidal and the amplitude of which is varied at intervals during the test. These have shown that Miner's predicted fatigue life may differ from that measured by factors up to 30. However, to our knowledge, there had not been any fatigue tests carried out with a random stress waveform. A random-noise fatigue machine has therefore been constructed, and a typical time trace of the stress produced in the specimen is shown in Fig. 1. The fatigue machine consists of a thermionic noise

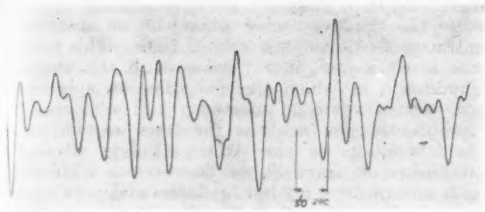

Fig. 1. Typical stress wave-form in specimen

source, the random output voltage from which is amplified by a 20-W. amplifier. This drives a moving-coil vibrator which is connected to the test specimen, stressing it in alternating bending. By substituting a sine-wave source for the random-noise generator, conventional constant-amplitude fatigue tests may be carried out in the same machine. Using 24 *ST* aluminium alloy specimens, the fatigue life at eight sine-wave stress levels and two random-noise levels was determined using five to seven specimens at each level. Mean and minimum S—N curves were drawn through the sine wave results, and with these, Miner's rule and the probability distribution of stress peak amplitudes in the noise wave form (as given by Rice[2]), the mean and minimum predicted fatigue life at the two noise levels could be calculated. These are compared with the measured fatigue lives in Table 1. It will be seen that the predicted life is longer than that found experimentally by a factor of 2–3·5. In the calculation of predicted lives, Miner's rule has been used in its most severe form, namely, that a given stress peak is counted as equivalent to a half-cycle of a sine wave of the same peak amplitude with zero mean load. It is known that other interpretations of Miner's rule lead to even longer predicted lives.

Table 1. Comparison of Predicted and Experimental Fatigue Lives under Random Loading

	Average fatigue life in 'cycles'			Minimum life in 'cycles'		
	Experimental	Predicted	Ratio	Experimental	Predicted	Ratio
Noise 1	$2{\cdot}0 \times 10^5$	$6{\cdot}9 \times 10^5$	3·45	$8{\cdot}8 \times 10^5$	$3{\cdot}0 \times 10^6$	3·40
Level 2	$1{\cdot}15 \times 10^5$	$3{\cdot}4 \times 10^5$	2·96	$7{\cdot}3 \times 10^5$	$1{\cdot}5 \times 10^6$	2·06

Note: A maximum and a minimum of the random wave form is counted as one 'cycle'.

In effect, the motion of the specimen (and the corresponding stress produced) is an amplified version of the Brownian motion of the resonant system formed by the mass of the moving coil of the vibrator and the spring of the specimen. To produce the amplitudes used in these tests by thermal activation would require a temperature of 10^{17}° K. The contribution of the room-temperature Brownian vibrations of the system to the stress level is quite negligible, a rough calculation of the fatigue life under these stresses giving a life of $10^{10^{21}}$ sec.

Full details of this work will be published elsewhere. For permission to publish this communication we thank the Chief Scientist, Department of Supply.

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Metal Ion Catalysis and Polarity of Environment in the Aerobic Oxidation of Unsaturated Fatty Acids

It is frequently stated that the intense activity of certain metallic compounds as oxidation catalysts is a matter of great technological interest and that knowledge of how these compounds react is still obscure in many details[1]. The foundations of a better understanding of the mechanism of metal ion catalysis were laid by Haber and Weiss[2]. The most notable recent advances in this field were made by C. E. H. Bawn[3] and his school. It is now generally accepted that the aerobic oxidation of linoleic acid and its esters proceeds through a chain reaction with the free radicals $R\cdot$ and $RO_2^\cdot$ as chain carriers, namely:

$$R\cdot + O_2 \rightarrow RO_2^\cdot \quad (1)$$

$$RO_2^\cdot + RH \rightarrow ROOH + R\cdot \quad (2)$$

The most difficult aspect is the initial production of free radicals. It is this aspect which is most directly related to metal catalysis. The following heavy-metal stearates were prepared and their catalytic effect examined: cupric, ferric, (partially oxidized) ferrous, cobaltous, manganous, cerous, vanadyl, thallous and stannous stearates. The latter two were investigated with the object of determining whether two-electron transfer would be more efficient than one-electron transfer in the initiation process. In the polar solvents ethyl alcohol, ethyl acetate and ethyl caprylate, none of the heavy metal stearates had any appreciable catalytic activity at 25° C., approximately $0{\cdot}1\,M$ methyl linoleate (or linoleic acid) and a catalyst concentration equal to or less than $M/5{,}000$. In dilute benzene solutions, cobaltous, manganous and cerous stearates were the only active catalysts leading to hydroperoxide formation. At a catalyst concentration of $M/5{,}000$, 25° C. and $0{\cdot}1\,M$ methyl linoleate, the rates of formation of hydroperoxide were approximately seven, five and four milliequivalents methyl linoleate hydroperoxide per mole methyl linoleate per hour with cobaltous, manganous and cerous stearate, respectively. Cupric stearate did not catalyse the formation of hydroperoxide but appeared to be an active catalyst in its decomposition into unsaturated aldehydes and ketones. The activation energy of hydroperoxide formation catalysed by cobaltous stearate was determined as 20 k.cal.

An even more pronounced catalytic effect was obtained with some heavy-metal phthalocyanines and octamethyltetrazaporphins (conjugated macrocycles), which were readily measurable at 25° C. in dilute benzene solutions down to a catalyst concentration of $5 \times 10^{-8}\,M$ ([methyl linoleate] $= 0{\cdot}1\,M$). The observed rates of hydroperoxide formation with ferrous phthalocyanine, cobaltous phthalocyanine and cobaltous octamethyltetrazaporphin (these substances were kindly supplied by Dr. J. A. Elvidge, of the Imperial College of Science and Technology) were about two milliequivalents per mole methyl linoleate per hour, at 25° C., a catalyst concentration of $5 \times 10^{-7}\,M$ and a substrate concentration of $0{\cdot}1\,M$. This is ten times the rate of the (apparently) uncatalysed reaction under similar conditions.

The general rate law for the aerobic oxidation with the heavy-metal catalysts in organic solvents was established as:

$$\frac{d[ROOH]}{dt} = k[RH]\,[\text{catalyst}]$$

A kinetic analysis indicated that this rate equation would be compatible with the general scheme:

$$Co^{2+} + O_2 \rightleftharpoons Co^{2+}.O_2$$
$$Co^{2+}.O_2 + Co^{3+}(XH) \rightarrow Co^{2+} + Co^{3+}X^- + HO_2^{\cdot}$$

$HO_2^{\cdot}$ radicals thus formed would initiate the chain reaction (1) and (2). The direct formation of $HO_2^{\cdot}$ by the reaction $RH + O_2 \rightarrow R\cdot + HO_2^{\cdot}$ is very much slower, as the endothermicity of this reaction would exceed 40 k.cal.[4] (the reaction $H + O_2 \rightarrow HO_2^{\cdot}$ being exothermic to an extent of approximately 35 k.cal.). The existence of similar complexes with molecular oxygen was recently postulated by J. Weiss[5] and P. George[6] in the aerobic oxidation of ferrous ion in aqueous solution.

The solvent effect was studied quantitatively in a mixture of the polar nitrobenzene (dielectric constant 37) and the non-polar benzene (dielectric constant 2·29). The effect was of such magnitude that I consider it must be attributed to the formation of different co-ordination spheres, which would alter the oxidation-reduction potential and the affinity to oxygen of the heavy-metal catalyst. The magnitude of this effect is illustrated in Table 1.

Table 1. EXPERIMENTS (AT 25° C.) WITH VARYING NITROBENZENE CONCENTRATIONS IN BENZENE–NITROBENZENE MIXTURES AND BLUE (ANHYDROUS) COBALTOUS STEARATE AS CATALYST
Total volume, 7·5 ml., including 0·5 ml. methyl linoleate (0·202 *M*)
[Cobalt stearate] = $1·87 \times 10^{-4}$ *M*

Nitrobenzene (Vol. per cent)	Molar ratio $(C_6H_6)/(C_6H_5NO_2)$	Rate of formation of the hydroperoxide (m.equiv./mole methyl linoleate/hr.)
0	—	14·4
25	3·47	13·4
30	2·70	12·3
35	2·14	7·6
40	1·74	3·88
45	1·42	1·86
50	1·16	0·68
75	0·385	Nil
100	—	indistinguishable from blank tests

When the logarithm of the rate of hydroperoxide formation was plotted against the logarithm of the molar ratio benzene : nitrobenzene, the curve obtained was nearly parallel to the abscissa axis at low nitrobenzene concentrations ($\ll$ 25 per cent) with a gradually increasing slope which reaches the limit of six at about 50 per cent nitrobenzene. This would be in accordance with expectation if, as we assume, the cobaltous stearate solvated by benzene is catalytically active whereas the nitrobenzene-solvated compound is inactive. The limit slope of six would imply an inner co-ordination sphere with six solvent molecules.

There is also a distinct solvent effect due to co-ordination with the metal phthalocyanine catalysts; however, this effect has not yet been studied quantitatively. It was observed that the heavy-metal complexes of conjugated macrocycles were not affected by the addition of malic acid. On the other hand, the catalytic effects of cobaltous and manganous stearate in benzene at a concentration of $M/5{,}000$ were quantitatively suppressed when malic acid was added at a molar ratio greater than 1 : 1. The catalytic activity of the heavy-metal porphin derivatives can be inhibited by the addition of free radical acceptors such as butylated hydroxy anisole, and in my experience even more effectively by quercetin and rhamnetin. The latter two substances merit more attention as efficient antioxidants.

The observations relating to the solvent effect (in the co-ordination sphere) have their practical counterpart in the storage of dehydrated food products, where oxidative rancidity abruptly sets in and becomes the decisive factor when the moisture concentration drops below a critical limit. This critical limit is connected, in my view, with the stage in dehydration in which the co-ordination spheres of trace metals would be affected.

Radioactivation analysis for trace metals (after pile irradiation at the Atomic Energy Research Establishment, Harwell) was carried out with crude lipids and purified methyl linoleate, and preliminary results indicate that even the trace-metal content of purified methyl linoleate is of an order of magnitude comparable with the concentrations in which catalytic effects with the heavy metal porphin derivatives were observed.

I wish to thank Miss M. R. Menzies for her assistance in the experimental work. A detailed account of this investigation will be published elsewhere.

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Absorption Spectra arising from the Photolysis of Lead Tetramethyl

THE flash photolysis technique[1] has been used to examine the photochemical decomposition of lead tetramethyl. At an energy of 2,500 joules (50 μF.; 10 kV.) the decomposition of lead tetramethyl at pressures up to 12 mm. mercury was shown to be largely complete in 1·2 m.sec. after the initial light flash; this was the time for the reaction vessel to become opaque to light due to the deposition of a lead film. The contents of the quartz reaction vessel (volume 500 cm.^{3}, surface/volume = 1·6) were examined in this interval by passing a second light flash through the length (1 metre) of the vessel into a large Littrow (Hilger *E*1) spectrograph using a slit width of 0·02 mm.

The absorption system shown (Fig. 1) was observed within 200 μsec. of the initial light flash. It consisted of a number of sharp lines due to atomic lead, together with a number of absorption regions not previously described (Table 1). The most prominent feature occurs with a maximum intensity at 3196 A. On exposures where this band is most intense, further bands are observed at shorter wave-lengths along with continuous absorption over the region below 4000 A. and increasing in intensity towards the ultraviolet region. In addition, a further series of bands, sharply degraded towards the violet and with heads at 2948, 2932, 2915 and 2899 A., have been seen on several occasions.

Analysis of the lead film on the walls of the vessel showed the photolysis to be very nearly quantitative. The efficiency of the photolysis lamp was determined by actinometry with uranyl oxalate[2]. At a vapour pressure of 12 mm. mercury the amount of lead deposited gave a quantum yield of about forty. The product gases on analysis were found to contain largely ethane (more than 90 per cent) and only a trace of methane. It would appear that a chain

reaction, based on methyl radical attack on lead tetramethyl, is involved, in competition with the reaction of two methyl radicals, to give ethane. The abstraction of hydrogen by methyl to yield methane occurs to a very minor degree.

A sample of fully deuterated lead tetramethyl was prepared from methyl-d_3 bromide[3] via the Grignard compound and lead chloride. On photolysis it behaved in an identical manner, with no significant change in the absorption system. If the observed spectra are associated with the methyl radical, then deuteration may be expected to have a marked effect. Assuming the primary photolytic act is rupture of the lead–carbon bond:

$$Pb(CH_3)_4 \rightarrow CH_3^{\cdot} + {}^{\cdot}Pb(CH_3)_3$$

the lead trimethyl fragment may equally well give rise to the absorption system observed. Deuteration would in this case be expected to have little effect. Photolysis of lead tetra-ethyl also resulted in a deposit of lead on the reaction vessel; but only continuous absorption was observed from 4000 A. towards shorter wave-lengths.

* Atomic lead lines

Fig. 1

Table 1. ABSORPTION SPECTRA ARISING FROM THE PHOTOLYSIS OF LEAD TETRAMETHYL

λ (A.)	ν (cm.$^{-1}$)	△ν (cm.$^{-1}$)	Intensity
3196	31,290	—	very strong
3096	32,300	1,010	weak
3039	32,910	610	very weak
3011	33,210	300	very weak
2948	33,920	710	weak
2931	34,120	200	weak
2915	34,305	185	weak
2899	34,490	185	weak

Photolysis of lead tetramethyl has also been attempted using a solution in *E.P.A.* glass[4] at 77° K. The apparatus closely resembled that described by Norman and Porter[5]. No absorption comparable to the system observed in the vapour phase has so far been detected. It is conceivable, in the light of recent work[6], that the absorption system observed arises from the lowest triplet level of ethane, which becomes populated through the excited ethane molecules formed by methyl radical combination. This work is still in progress and will be published in detail elsewhere.

We are indebted to the Chief Scientist, Department of Supply, Australia, for permission to publish this communication.

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Mathematical Chemical Periodicity

LENGTHS of the periods and atomic numbers, L and Z, of a bidimensional continuous system based on the electronic structure of the elements, are numerical characteristics precisely definable, as functions of the principal and orbital quantum numbers n and l ($0 \leqslant l \leqslant n-1$), by the following general equations:

$$L = \tfrac{1}{2}[n + l + f(n+l)]^2 - E$$

$$Z = \binom{n+l+2}{3} + \tfrac{1}{2}(n+l+1)f(n+l) - 2l^2 - E$$

In these equations, the term of the periodical discontinuity, $f(n+l)$, as a quantum number function, is

$$\tfrac{1}{2}[1 - (-1)^{n+l}] \text{ or } \cos^2 \tfrac{1}{2}\pi(n+l+1)$$

or an equivalent, and E is the number of missing electrons required for the completion of the subshell in which the given element occurs. For $E = 0$, one

expresses the distances from the last inert gas (partial lengths of the periods) and atomic numbers, respectively, of the subshell closing elements, so that, in the particular case of $n = 1$, the length of the complete periods and the atomic numbers of the inert gases are found.

The two equations correspond to previously obtained combinational expressions[1] which here have been given a most convenient simplification. By placing the periodicity term $f(n + l)$ in algebraic form, L can reduce to the Tomkeieff's rule[2] ($E = 0$; $l = 1$), and Z becomes analogous to Hakala's law[3]. Thus they are shown to achieve wider generalization than the hitherto known formulæ.

Moreover, the close relationship established between L and Z constitutes synthetic mathematical evidence of a bidimensional double periodicity in the chemical table.

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Thermodynamic Interpretation of the Eötvös Constant

Eötvös[1], in 1886, proposed the following equation for liquids

$$\gamma(M\upsilon_{sp.})^{2/3} = K_E\,(T_c - T) \qquad (1)$$

where γ is surface tension, M is molecular weight, $\upsilon_{sp.}$ is specific volume and T_c is critical temperature, which is found to be strikingly valid over a wide range of temperature for most non-polar compounds. Even for polar compounds the equation is valid though to a more limited extent; but the value of the constant, K_E, is often very different from the usual value, 2·12. This empirical equation has been given some theoretical support (cf. Partington[2]). The purpose of the present communication is to point out a simple thermodynamic interpretation of the above equation.

Since the left-hand side of the equation is a free-energy term and the right-hand side is linear in T, its formal similarity with the standard thermodynamic equation, $\Delta F = \Delta H - T\Delta S$, is apparent. Based on this we can identify the Eötvös constant as the entropy of formation in proper units of $(M\upsilon_{sp.})^{2/3}$ surface area starting from liquids in the interior. Since a mole of a liquid considered as a cube presents an area of any face equal to $(M\upsilon_{sp.})^{2/3}$, and since this cube can be divided into $N^{1/3}$ such faces, the molar entropy is easily obtained by multiplying both sides of equation (1) by $N^{1/3}$. Converted into calories, we obtain the molar entropy of surface formation for non-polar compounds,

$$2{\cdot}018 \times K_E \text{ cal./deg.} = 4{\cdot}28 \text{ entropy units}$$

Thus we arrive at the interesting conclusion that the Eötvös constant is a measure of the entropy of formation of surface and the entropy change in bringing liquid molecules from the interior to the surface is the same for all non-polar liquids and nearly the same for all liquids, and is equal to 4·28 calories per degree per mole. In other words, the Eötvös equation is the liquid-surface analogue of Trouton's law relating to vaporization.

It seems plausible that this excess entropy on the surface is almost wholly configurational, arising out of increased symmetry in the interior of a liquid and the non-spherical shape of liquid molecules. This idea is supported by the fact that the corresponding entropy changes for alcohols are much lower, being 1·88 for methyl alcohol and 2·18 for ethyl alcohol. This loss of entropy for polar liquids is thus to be ascribed to the well-known orientation of such molecules on the interface. This also agrees with the observation that mercury ($K_E \simeq 1$), which presumably has more or less spherical molecules, has a lower Eötvös constant, and geometrically complicated molecules, for example, tripalmitin ($K_E = 5{\cdot}4$), have higher Eötvös constants.

Conversely, a thermodynamic deduction of Eötvös equation from the above assumption, the temperature independence of ΔH, and the boundary condition of zero free-surface energy at the critical temperature, is simple and need not be elaborated here. The next step would be to investigate the possibility of deduction of the numerical value of K_E from statistical thermodynamics.

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Oxidation-Reduction Potential of Modified Cytochrome *c*

The presence of modified cytochrome *c* in the widely used Keilin and Hartree preparation was first reported by Margoliash[1]. Separation was effected by chromatography at *p*H 7·0 on a column of the resin 'Amberlite *IRC*-50'. Modified material was present to the extent of 10–25 per cent and was characterized by having a lowered enzymatic activity in the cytochrome oxidase (heart muscle) and succinic oxidase (kidney) systems but an increased rate of ascorbic acid oxidation. Visual spectroscopy, however, did not show any difference between this and other cytochrome *c* fractions. Evidence was presented that the modification was caused by the action of trichloracetic acid on cytochrome *c* during the extraction procedure.

We have recently compared[2] the E'_0 values at *p*H 6·4 and 25° C. of the usual Keilin and Hartree type preparation with cytochrome *c*, purified on a resin column, from both ox- and horse-heart muscle. It was suggested that the slightly higher value of the less pure samples (0·270 V.) compared with the resin-purified samples (0·255 V.) was due to the presence of modified cytochrome *c*. We have now determined the E'_0 value of this material as separated by the above procedure from ox-heart cytochrome *c* and find it to be 0·310 V. under the same conditions of *p*H and temperature.

In order to attempt its complete modification, a sample of ox-heart cytochrome *c* purified on a resin column was subjected to prolonged treatment with trichloracetic acid (2·5 per cent, 18 hr. at 25° C.), followed by dialysis against 0·5 per cent sodium chloride. The potential of the resulting pigment

solution was found to be very close to the above value, namely, $E'_0 = 0{\cdot}308$ V. at *p*H 6·4 and 25° C. This material did not show any increased ascorbic acid oxidase effect over the values usually obtained for Keilin and Hartree preparations of cytochrome *c*. There was present, however, after the above dialysis, a small residue of cytochrome *c*-like material, soluble in dilute ammonium hydroxide. This had a seven-fold increase in catalytic effect on the oxidation of ascorbic acid. The potential of this residue has not as yet been determined. Absorption curves for these fractions, reduced with sodium dithionite, revealed band positions identical with those of resin-purified cytochrome *c*. However, differences in the degree of light absorption were observed, particularly on the longer wave-length slopes of the α-bands.

The increase in E'_0 value of cytochrome *c* on modification brings about what is almost certainly a critical shift of its position in the classical picture of stepwise tissue oxidation as proposed by Ball[3]. Although it is not yet possible to define the nature of such modification which results in an increase of just over 50 mV. in the potential-level, it is clear that the effect must be taken into account in assessing the results of studies involving the catalytic functions of cytochrome *c*.

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Tocopherol Content of Heart-muscle Preparations

The possible role of vitamin E in respiratory enzyme systems has often been suggested; but supporting evidence of the actual presence of vitamin E in active enzyme preparations has not been published. We have now found appreciable amounts in heart sarcosomal (mitochondrial) fragments (Keilin and Hartree heart-muscle preparation).

Sarcosomal fragments prepared by one of us (E. C. S.) in Cambridge were analysed by Dr. K. L. Blaxter and Miss R. F. McGill at the Hannah Dairy Research Institute, Scotland. The first preparation showed no tocopherol activity measured as the free alcohol or its esters. When, with later preparations, the non-saponifiable material from alcoholic extracts of dried sarcosomal fragments was treated with stannous chloride in dioxane in order to reduce any oxidized tocopherol which might be present, an appreciable amount of material reducing ferric chloride was obtained. This behaved like α-tocopherol on reversed-phase chromatography[1]. In view of these results, a more detailed investigation was made in the Amsterdam laboratory.

The freeze-dried preparation of sarcosomal fragments (4 gm., containing 2·40 gm. protein) was extracted with dry alcohol containing pyrogallol, and the extract saponified. The ethanolic solution of the non-saponifiable fraction was refluxed with ascorbic acid in strong hydrochloric acid to convert any tocopherylquinone to tocopherol. After removal of sterols by treatment with methanol, and

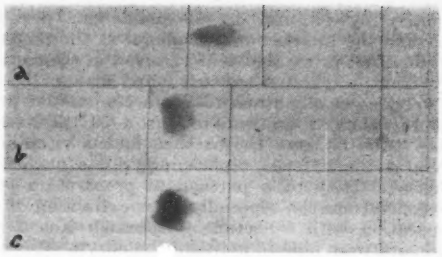

Fig. 1. Paper chromatogram, made according to the procedure of Green *et al.* (ref. 2): *a*, pure α-tocopherol (20γ); *b*, purified extract from heart sarcosomal fragments (0·02 ml.); *c*, α-tocopherol (20γ)+the purified extract (0·02 ml.). The papers were sprayed with ammoniacal silver nitrate, and the excess reagent removed with sodium thiosulphate

of carotenoids by passage through a column of 'Floridin *XS* Earth', the ethanolic solution containing the tocopherol was subjected to the paper-chromatography procedure of Green *et al.*[2]. A spot was obtained of an R_F a little more than that of a pure solution of α-tocopherol run simultaneously (Fig. 1). When, however, α-tocopherol was added to the alcoholic solution derived from the heart-muscle preparation, one spot only was obtained. No β- or γ-tocopherol, which is readily separated from α-tocopherol by this procedure, was detected.

The identity of the material giving the spot on the chromatogram with α-tocopherol was confirmed by extraction with ethanol and oxidation with ferric chloride. The oxidation products were extracted with petroleum ether, and after evaporation dissolved in ethanol. This solution showed the typical two-banded spectrum obtained with tocopherol oxidized under these conditions. The positions of the bands (262 mμ and 269 mμ) coincided exactly with those ascribed to toco-red[3].

The amount of α-tocopherol was determined by extraction of the area of the spots with warm ethanol, followed by estimation of the tocopherol content by the method of Emmerie, using the spot with added α-tocopherol as an 'internal standard'. The amount found was 1·1 μmole per gm. protein. This value refers to α-tocopherol plus its oxidation products (for example, α-tocopheroxide or α-tocopherylquinone) which might be present in the heart-muscle preparation. It does not, however, include any tocopheryl-hydroquinone, which would probably not be extracted into the non-saponifiable fraction. It is hoped that further investigations will reveal the form of tocopherol which is present in the heart-muscle preparation.

Vitamin E is the only fat-soluble vitamin present in the heart-muscle preparation in appreciable amounts. The preparation contains less than 0·01 μmole vitamin K/gm. protein (analysis kindly carried out by Miss I. Kruse, of the Department of Biochemistry and Nutrition, Danish Polytechnic Institute, Copenhagen), less than 0·03 μmole vitamin D/gm. protein (analysis kindly carried out by Dr. E. Kodicek, of the Dunn Nutritional Laboratory, Cambridge) and less than 0·01 μmole vitamin A/gm. protein (our own analysis). These values are so low that it is unlikely that any of these vitamins are involved in the non-phosphorylating respiratory chain of the sarcosomal fragments.

On the other hand, the amount of α-tocopherol (1·1 μmole/gm. protein) is of the same order of magnitude as of known components of the chain (for

example, cytochrome *c*, 0·8 μmole/gm. protein). Although the presence of tocopherol in the preparation does not prove that it is involved in the respiratory chain, the actual amount found makes this not unlikely, especially when taken in conjunction with the important experiments of Nason and Lehmann[4]. These authors have shown that added vitamin E activates the reduced diphosphopyridine nucleotide oxidase activity of a particulate preparation from rat skeletal muscle, especially after extraction of the preparation with *iso*-octane. Although Nason and Lehmann were able to activate the enzyme preparation by the lipid present in the *iso*-octane extract, they were unable to detect vitamin E in the extract. We have been able to show the presence of α-tocopherol (or its oxidation products) in *iso*-octane extracts of suspensions of the heart-muscle preparation.

We are grateful to Dr. G. Baxter, Distillation Products, for supplying samples of pure tocopherols.

Note added in proof (June 1). Nason *et al.*[5] have recently shown that the reduced diphosphopyridine nucleotide oxidase system in the rat muscle preparation could be reactivated by high concentrations of crystalline serum albumin, as well as by α-tocopherol. Albumin, previously extracted with *iso*-octane, was ineffective. We have now found that crystalline bovine serum albumin (Armour) contains 0·056 μmole α-tocopherol/gm. protein.

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Pharmacological Action of Rauwolscine

Rauwolscine (kindly supplied by Mrs. A. Chatterjee, University College of Science and Technology, Calcutta), an alkaloid of *Rauwolfia canescens* Linn.[1], has been found to be a potent adrenolytic compound[2,3]. It has further been shown to be α-yohimbine[4]. Yohimbine is an adrenergic blocking alkaloid; but it produces certain other effects, such as stimulation of the central nervous system, local anæsthesia and vague aphrodisiac activity[5], which have precluded its use in clinical practice. No detailed report has appeared so far of any investigation of these properties; we have therefore examined these pharmacological actions of rauwolscine with the following results.

(1) A 2 per cent solution of rauwolscine giving a visible film on the guinea pig cornea produces complete surface anæsthesia starting 5–7 min. after instillation and lasting up to 15–20 min.

(2) 0·25 c.c. of a 0·2–2·0 per cent solution of rauwolscine in normal saline (*p*H 5·2–5·5) produced local anæsthesia in guinea pigs as tested by the method of Bülbring and Wajda[6], and lasts more than 2 hr. This, however, appears to cause local damage to the tissues.

(3) 10–20 mgm./kgm. injected intraperitoneally into guinea pigs produces signs of psychic excitement and erection in the male animals. The animals become highly excitable and restless.

(4) 25 mgm./kgm. injected intraperitoneally in rats lowers the convulsant threshold level of metrazol.

(5) 12–15 mgm./kgm. injected intravenously in rabbits produces sudden clonic convulsions lasting 2–3 min., accompanied by increased respiratory-rate and followed by sexual excitement. When injected intraperitoneally, 20 mgm./kgm. produces no convulsions but other effects; for example, increased motor activity, psychic excitement and increased respiration appear in 5–10 min.

A comparison of the adrenergic blocking activity of rauwolscine with 2-benzyl-imidazoline hydrochloride ('Priscol', Ciba), an agent recommended in the treatment of peripheral vascular diseases on the basis of its adrenolytic activity, was also undertaken. This study was carried out on the isolated guinea pig seminal vesicle following the method described by Stone *et al.*[7]. In concentrations of 1 in 250,000 to 1 in 80,000, the two compounds show nearly equivalent adrenolytic activity; but in higher concentrations, for example, 1 in 60,000 to 1 in 50,000, tolazoline produces only 40–50 per cent adrenolysis whereas rauwolscine produces 81–93 per cent.

These studies thus indicate that in low concentrations rauwolscine possesses marked adrenolytic activity; but in relatively higher dosages it has some of the side-effects of yohimbine. Detailed comparison between rauwolscine and yohimbine and other adrenolytic compounds is now being carried out to determine the clinical potentialities of rauwolscine.

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Assimilation of Berberine by Bacteria

Berberine hydrochloride has been reported to be toxic in weak concentrations against some species of bacteria[1] and some fungi[2]. Recent studies in this laboratory have shown that several species of bacteria assimilate the alkaloid from media provided with suitable nutrients, as well as from extracts of plants containing berberine and chelidoxanthine.

Some of the bacteria tested are sensitive to berberine and do not grow at a concentration of the hydrochloride as low as 0·0025 per cent; others resist and are able to absorb it from media containing as much as 2 per cent. The bacteria, during growth, absorb (assimilate) the pure alkaloid into their protoplasm but do not use it either as a source of carbon or of nitrogen. The evidence for absorption is found by the bright yellow fluorescence of the cells in ultra-violet light, of the same fluorescence as that of the alkaloid, whereas there is only minimal absorption of washed resting cells in saline or nutrient-free media.

The cells, moreover, which have absorbed the alkaloid, when washed and used as a source of

organic nitrogen in an otherwise berberine-free nutrient medium, serve to supply other bacteria with nitrogen. The bacteria that utilize the nitrogen of 'berberinized' cells may be the same species that provided the nitrogen, or other species. Evidence of this 'secondary assimilation' is found both in the yellow fluorescence of the second-culture cells, and in the clear zones of proteolysis surrounding their colonies on agar plates.

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Flight-muscle Changes during Adult Life in a Scolytid Beetle

It has long been known that in ant and termite queens the wings are lost and the flight muscles degenerate after the mating flight. Recently, flight-muscle degeneration has been reported in aphids[1] and mosquitoes[2], although in the latter group further studies appear to be desirable[3]. In the Coleoptera, protection of the posterior membranous wings, when at rest, by the tough anterior wings or elytra makes possible utilization of confined habitats, such as burrows of various types, which are unavailable to many other winged insects. Whether or not such protection is related to loss or reduction of wings, the fact remains that in several families of this group flightless species have evolved[4]. Most of these species have membranous wings greatly reduced in size; but small wing muscles and other morphological indications of loss of the ability to fly have been noted in some instances where wings are normal. Certain species are variable with respect to capacity for flight, some individuals being able to fly although others are not. A seasonal change in flight muscles has been noted in a weevil, and evidence suggests that such a change occurs in certain water beetles.

I have recently investigated the capacity and inclination to fly in a member of the Scolytidae, the ambrosia beetle, *Trypodendron lineatum* (Oliv.). Individuals have been flown on fixed mounts or flight mills and have been tossed into the air at various times during their adult life. Beetles taken in the spring often show considerable capacity for flight. Some will fly for several (up to eight) hours continuously on flight mills or on fixed mounts. Individuals taken in flight will fly immediately when tossed; but those removed from well-established galleries will not.

In this species the young adults, after a feeding period within the galleries, generally fly from the brood logs to their over-wintering site and again the following spring when they carry out their first attack. The parent adults also fly from the brood logs in the first season and may attack other material then or in the following season, producing another brood in either case. Young or parent adults taken from galleries before natural emergence usually will not fly when tossed. They take to flight, however, after a period of time at room temperature.

Dissection of parent adults of either sex removed from galleries containing eggs or larvæ reveals that the large indirect flight muscles are greatly reduced in size, to such an extent that they have almost disappeared. In the females, the much enlarged ovaries project forward into space normally occupied by these muscles. In both sexes the ventriculus is enlarged at this time and also fills part of this space. Parent adults taken just before they emerge naturally from galleries, however, have large flight muscles which appear normal. We thus have an example of temporary but marked reduction in size of flight muscles during brood establishment, followed by return to normal size and, apparently, function.

The reduction of flight muscles occurs at a time of adult activity without feeding and, consequently, of depletion of metabolic reserves. Later, the beetles feed intensively within the galleries, and this permits a building up of these reserves and presumably affects the redevelopment of the flight muscles. The details of the changes in these muscles, however, remain to be worked out.

The flightless period during adult life has ecological significance in that beetles cannot abandon their galleries by flight during this time. It seems likely that the phenomenon occurs in other members of the Scolytidae also, as the pattern of life within the entire family is essentially similar and involves long periods within plant tissue preceded by, or alternating with, relatively brief periods of flight. In any event *Trypodendron* shows an interesting compromise, within the Coleoptera, between the need for sustained flight at certain times and the occurrence of long periods of adult activity in burrowing and establishing a brood in a protected and confined habitat, where flight is not necessary.

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Heat Increments of Feeding in Ruminants

In ruminants the heat losses associated with carbohydrate dissimilation amount to 30–70 k.cal./100 k.cal. carbohydrate digested[1], whereas in man such losses are only 5–7 k.cal./100 k.cal.[2]. In calorimetric experiments with fasted sheep, we have found that the steam-volatile fatty acids which are the major end-products of rumen fermentation of carbohydrate produce a greater heat increment than does glucose given under similar conditions, precautions having been taken to minimize bacterial fermentation of the sugar. Furthermore, in starved animals, and also in those receiving food, the energy-loss as heat is considerably greater for acetic acid than for propionic or butyric acids.

A typical starvation experiment was as follows. A fasted sheep, with a permanent rumen fistula, was confined in a respiration chamber[3], and physiological saline (6,570 ml./24 hr.) was dripped into its rumen at a constant rate. Oxygen consumption, carbon dioxide and methane production, urinary nitrogen and ketone body-excretion were measured

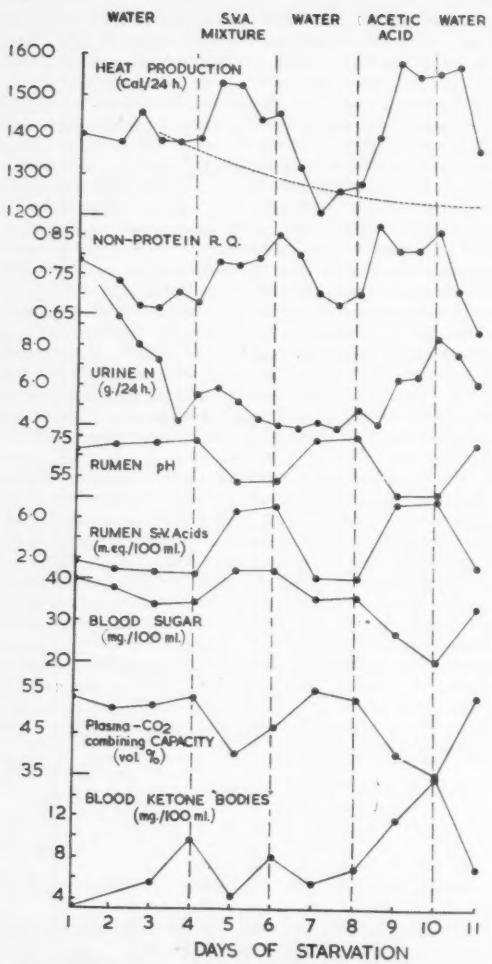

Fig. 1. Effect of a steam-volatile acid mixture, molar proportions, acetic acid 50, propionic acid 30, butyric acid 20 and of acetic acid alone on the metabolism of a fasting sheep

at 12-hr. intervals. The blood content of sugar, steam-volatile acids and ketone bodies, the carbon dioxide combining capacity of the plasma and the *p*H and steam-volatile acids content of the rumen liquor were determined every 24 hr. When constant values of oxygen consumption and a respiratory quotient of 0·70–0·73 were obtained, the physiological saline was replaced by the same volume of a mixture of acetic, propionic and butyric acids in the molar proportions 50 : 30 : 20, to supply 1,100 k.cal. in 24 hr. The acid mixture contained the same amount of modified saline as before and was given for 48 hr. The animal then received water and saline for a further 48 hr., followed by a similar period during which it received an acetic acid solution supplying 700 k.cal./24 hr. The sheep was then returned to the saline regimen for a final 24-hr. period. The results are summarized in Fig. 1.

The mixed steam-volatile acids did not depress the rumen *p*H beyond the limit of the normal physiological range, although initially a slight systemic acidosis developed. There was an appreciable rise in blood glucose. From the increase in oxygen consumption and carbon dioxide production, and from the elimination of urinary nitrogen, the heat increment, that is, the extra heat lost on giving the mixture of acids expressed as a percentage of the total calorie content of the acids, was calculated to be 16 per cent.

During the administration of acetic acid the very marked rise in heat production that occurred amounted to between 46 and 50 per cent of the energy input. A systemic acidosis developed with the accumulation of volatile acids in the peripheral blood. A decline in blood sugar, an increased excretion of nitrogen in the urine and a ketonæmia also occurred.

Further experiments have confirmed the high (44–50 per cent) heat losses associated with dissimilation of acetic acid in the fasting sheep; in the fed animal even higher heat losses (56–61 per cent) occur. These results suggest that the efficiency of free-energy capture in acetic acid dissimilation is very appreciably lower than that from hexose or from butyric and propionic acids. It should be pointed out that in these experiments the acids have been given at constant slow rates in amounts which may be regarded as physiological.

The results may do much to explain the fact that heat increments in ruminants vary with the fibre content of the food[1], since the proportion of acetic acid in the fermentation products increases with increasing fibre content[4]. Whether measurements *in vitro* of the molar proportions of the steam-volatile acids formed when different foodstuffs are fermented by mixed rumen organisms will permit prediction of the heat increments of rations remains to be seen.

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Invagination as an Organic Process

It may be worth while pointing out that invagination is an organic process which is now known to occur at three levels of organic structure: (1) invagination of cells in the process of gastrulation. (2) invagination or ingrowth of furrows in the process of wall formation in the pollen mother cells of certain angiosperms, (3) ingrowth of dissepiments in the development of mitochondria in animal cells. The process thus applies to cell masses in gastrulation, to cell-wall formation in certain pollen mother cells, and to an organelle in the cytoplasm of animal cells.

There appears to be nothing in the inorganic world which corresponds to this organic process. On the contrary, the growth in length of plant cell walls through intussusception under the influence of auxin is followed by the apposition of thickening layers of fibrils in a manner resembling crystal growth; but the regularity of the microfibrillæ as seen under the electron microscope never quite equals that of the molecules in a crystal.

Gastrulation of the blastula by invagination to form the archenteron is too well known to need comment. It occurs in invertebrate embryos, amphibians and reptiles, and is recognized in modified form in birds and mammals. The forces and processes inducing it have been much studied by experimental embryologists.

Gastrulation may be said to result from unequal mitotic-rates in cells of the blastula having different sizes, contents and potentialities, especially those of the organizer at the dorsal lip of the blastopore, where a meristem gives rise to both ectoderm and endoderm cells. The fundamental nature of this process arises not only from its widespread occurrence in animal embryology but also from the fact that in totipotent eggs single blastomeres of the 16- or 32-cell stage of the blastula are capable of forming embryos which undergo gastrulation.

No corresponding process occurs in plants at this level of structure, except in the reproductive stages of certain algae, such as *Volvox*[1]. Here the blastula-like hollow sphere of cells has an opening which corresponds to the blastopore. The latter opens out and the whole structure evaginates, turning itself inside out—a process in some respects the reverse of gastrulation.

The formation of cell walls by invagination or furrowing, thus cutting the pollen mother cell into four parts, was clearly described in *Lathraea*[2], in a paper which has been generally overlooked. Narrow, finger-like, hollow processes grow in from four points on the periphery of the mother cell and finally meet in the centre. As these furrows advance a delicate cell wall is secreted or laid down in their hollow interior. The same or a closely similar process has been described in the pollen mother cells of certain other plants, although in many Angiosperms the tetrad walls are laid down in a very different way, on the mitotic spindles. This furrowing process is very similar to the cell division by constriction which occurs in the cleavage stages of animal embryos. The only difference is in the narrower form of the cleavage furrows as described above in pollen mother cells.

The third form of invagination, in animal mitochondria, is most unexpected and has only come to light through the use of the electron microscope. Here again, thin, hollow, finger-like processes grow inward from the margin of the elongated mitochondrion. By reaching the opposite wall they divide the organelle into a series of compartments. This structure is now known in the mitochondria of mammals[3], invertebrates[4] (including insects), and Protozoa[5]. The universality of the septation of true mitochondria in animal cells seems to indicate that this organelle developed in animal cytoplasm at the unicell stage of evolution. Cytoplasmic granules which do not show septation should obviously be classed among the microsomes, though some of the latter may be preseptation stages of mitochondria. Thus the 'mitochondria' of bacterial cells are perhaps better considered as microsomes.

Pelade[3,6], in describing the mitochondria of rat liver, kidney tubules and striated muscle under the electron microscope, finds them surrounded by a membrane which appears double. Into the interior protrude ridges (cristae mitochondriales) which appear as parallel folds (*c.* 20 mμ in thickness) arising from the inner membrane. Pelade compares them with the villi of the intestinal mucosa. He suggests that the cristae serve to localize the oxidative enzymes known to be present in mitochondria. Sjöstrand[7] also describes the mitochondria as surrounded by a double membrane, the many cross-partitions also having a double membrane. In mouse kidney, Sjöstrand and Rhodin[8] find these cross-partitions to be double, the border membranes separated by a narrow space. Sjöstrand and Hanzon[9] find a similar structure in mouse pancreas cells, the double-edged membranes or plates being *c.* 170 A. thick.

From further evidence, Frey-Wyssling[10] concludes that the cristae arise as invaginations of the inner membrane, each invagination becoming a flat disk which takes the shape of a flattened bladder with a narrow neck. They are therefore true submicroscopic invaginations, as their double walls indicate. There is still, however, difference of opinion as to whether an osmotic membrane surrounds the mitochondrion[11,12]. Harman and Kitiyakara[13] find in the mitochondria of pigeon skeletal muscle no semi-permeable membrane but a gel-like internal matrix between the cristae.

It has been held that mitochondria undergo not only transverse but also longitudinal division. It is difficult to see how the latter could take place in a structure already septate.

The close relation of plant mitochondria to chloroplasts necessitates a different structure in them. Instead of septation the proplastid, according to the recent account of Mühlethaler[14], contains a single granum from which lamellæ grow out through the stroma of the plastid. This outgrowth again is an organic, in contradistinction to an inorganic, process, showing that even at submicroscopic levels purely physical (crystallizing) forces are not the only ones concerned in molecular alignments.

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18 Concord Avenue,
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April 20.

[1] Pocock, M. A., *Ann. S. African Mus.*, **16**, 523 (1933).
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[3] Pelade, G. E., *Anat. Rec.*, **114**, 427 (1952).
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A Rapid Method for Permanent Aceto-Carmine Squash Preparations

Most methods of preserving chromosome configurations prepared by aceto-carmine squash techniques involve either a somewhat lengthy procedure by which the tissues come to be mounted in balsam or 'Euparal', or else an effective sealing-off of the aqueous medium by ringing with 'Vaseline' or other impervious material. The former methods are time-consuming, and there is a risk that cells may become distorted in the process. The latter procedures are often unsatisfactory over long periods and frequently

necessitate storage in the refrigerator to prevent darkening and deterioration.

The following technique is remarkably simple and effective. Freshly prepared squashes are thoroughly irrigated with 45 per cent acetic acid to remove all excess stain. (This may be facilitated by wiping the edges of the coverglass, holding the latter securely at one corner.) A small drop of 10 per cent glycerine in 45 per cent acetic acid is then placed at the margin of the coverglass and allowed to flow under as the aqueous portion evaporates. Should bubbles appear after a day or two, another drop of the glycerine solution may be added.

Advantages of the method are: (1) It is very rapid. (2) It is truly permanent. Even though large areas under the coverglass become filled with air, the glycerine remains in the individual cells and prevents their distortion. (3) Should darkening occur, 45 per cent acetic acid may be added at the edge of the coverglass and the slide gently heated until correct differentiation is achieved. (4) If care is exercised to avoid adding too much glycerine, the coverglass is held so firmly in place (by the evaporation of the acetic acid) that it may be rubbed quite vigorously without danger of displacement when removing oil or dirt. (5) The glycerine is so inert and non-volatile that there is no problem of artefact formation or of the medium becoming discoloured or brittle. (6) The refractive index of glycerine is sufficiently close to that of balsam to give a good microscopic image. It has the further advantage of complete transparency to ultra-violet and near-ultra-violet light.

The method may be extended to other types of microscopic preparation where the final mounting medium is soluble in water, and where pressure of the coverglass is not deleterious or the tissue too thick. It has been used for many years in this Department, for example, for preparations of macerated cells.

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Nov. 22.

Sectioning of Soil

Many workers interested in soil microbiology or soil structure have attempted to impregnate soil with materials such as balsam in the hope that the soil could be hardened sufficiently to enable sections to be prepared by normal geological techniques. Few of these attempts met with much success. Kubiena[1] made considerable progress by introducing the use of a thermolabile plastic material, and was able to prepare sections showing the soil structure in many different soil types. However, Kubiena's technique does not seem to have given satisfactory results in the hands of other workers. Haarløv and Weis-Fogh[2] have developed a method for sectioning litter, using a hardened agar, but their method is unsatisfactory for mineral soil. More recently, Alexander and Jackson[3] have described the use of a marco-resin for impregnating the soil and preparing thin sections.

We have found that the procedure can be greatly simplified by using a 'Bakelite' polymeric resin *S.R.* 17497 and its associated catalyst and accelerator. The resin has a low viscosity, good wetting powers and sets at room temperature in 12–24 hr. to a hard water-white solid which can be ground with carborundum. The setting time can be controlled by varying the amounts of catalyst and accelerator.

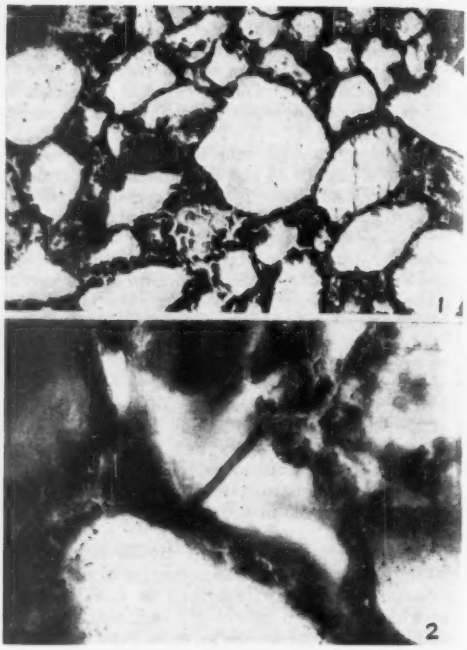

Fig. 1. B_1 horizon of a podzol, sand grains cemented with sesquioxide and humus. × 60 approx.

Fig. 2. Fungal hypha in pore space of the B_1 horizon. × 300 approx.

A piece of air-dry soil about 2 cm. × 1·5 cm. × 0·5 cm. is placed in a pool of resin on a slide. The resin readily fills the soil spaces, and after it has set the soil can be treated like a rock chip. The upper surface is ground to give the maximum surface area and then polished. The soil is taken off the slide and remounted in resin, polished side downwards. After the resin has set, the soil is ground down to a thin film and polished. Finally, it is mounted in resin under a cover glass. 'Carborundum' 280-grade has been used for the grinding and a No. 200 hone for polishing. Sections 50–60μ thick have been found suitable for the examination of the fungi in soil.

This method has been developed primarily for the study of fungal hyphæ in the soil; but mites, nematodes and thecate amœbæ have also been examined.

Fig. 1 shows the general distribution of quartz grains and the cementing sesquioxide and humus in the B_1 horizon of a podzol. In Fig. 2 a fungal hypha can be seen passing from the humus coating on one sand grain across the soil pore to another grain.

We would like to thank Messrs. Bakelite, Ltd., Redfern Road Works, Tyseley, Birmingham 11, for their kindness in supplying samples of resin.

Shirley Hepple
Alan Burges

Hartley Botanical Laboratories,
University of Liverpool.
Jan. 26.

[1] Kubiena, W. L., "Micropedology" (Ames, Iowa, 1938).
[2] Haarløv, N., and Weis-Fogh, T., *Oikos*, **4**, 44 (1953).
[3] Alexander, F. E. S., and Jackson, R. M., *Nature*, **174**, 750 (1954).

FORTHCOMING EVENTS

Monday, June 25

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. I. Bernard Cohen: "Some Aspects of the Aims, Methods and Influence of Newton's Scientific Work".

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. R. L. Metcalf (University of California): "Physico-Chemical Approach to Insecticide Action".

Thursday, June 28

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir K. S. Krishnan, F.R.S.: "The National Physical Laboratory of India".

Thursday, June 28—Saturday, June 30

BIOCHEMICAL SOCIETY (joint meeting with the SCANDINAVIAN BIOCHEMICAL SOCIETIES, in the Department of Biochemistry, Tennis Court Road, Cambridge), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B (graduate in mathematics, engineering or science, with teaching or industrial experience) IN THE DEPARTMENT OF MATHEMATICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester (June 26).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in mathematics and physics, or equivalent qualifications, post-graduate research experience, and preferably with a knowledge of the theory of the outer layers of a star and experience in stellar spectroscopy or photoelectric photometry), at the Royal Greenwich Observatory, Herstmonceux, Sussex, to take charge of the department conducting astrophysical work (as distinct from astrometric and solar work)—The Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4599/56/7 (June 29).

LECTURER IN THEORETICAL CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs (June 30).

LECTURER IN PHYSICS; ASSISTANT LECTURER IN CHEMISTRY; ASSISTANT LECTURER IN PHYSICS; and SENIOR LECTURERS (3) IN PHYSICS, at the Royal Technical College of East Africa—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (June 30).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PHYSICS, to work on atmospheric electricity—The Secretary, The University, 38 North Bailey, Durham (June 30).

BENGER RESEARCH FELLOW (graduate in medicine or science (including pharmacy)) IN PHARMACOLOGY—The Registrar, The University, Manchester 13 (July 1).

PRINCIPAL LECTURER IN APPLIED MECHANICS at the Royal Naval College, Greenwich—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4600/56/8 (July 2).

SOIL ANALYST (with a degree or equivalent qualification in chemistry and at least two years subsequent experience), at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 3).

CHEMIST (with an honours degree in chemistry or chemical engineering, or A.R.I.C., or equivalent qualifications) with the Ministry of Supply at Harefield, Middlesex, to assist in the technical direction of inspection of non-metallic aero materials, for example, metal–metal adhesives, windscreen glass, general chemicals and packaging materials, and to supervise all analyses, including spectrographic—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.388/6A (July 7).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (July 7).

SCIENTIFIC OFFICER (honours graduate) IN THE ENTOMOLOGY SECTION, for ecological and population studies of soil pests as affected by insecticides—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (July 7).

LECTURER IN ELECTRICAL ENGINEERING; LECTURER IN CIVIL ENGINEERING; and a LECTURER IN MECHANICAL ENGINEERING—The Assistant Secretary, The University, Edinburgh (July 9).

LECTURER or ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Manchester 13 (July 9).

LECTURER (preferably with a knowledge of some aspect of nuclear engineering) IN ENGINEERING (Mechanical)—The Registrar, The University, Manchester 13 (July 9).

LECTURER IN GEOLOGY—Head of the Department of Geology, Imperial College, London, S.W.7 (July 10).

SCIENTIFIC TECHNICAL OFFICERS (with physics qualifications, preferably graduate), for research teams working on problems in classical physics, heat transfer and mechanical properties of materials and compacts for the preparation of special fuels from coal—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting 88/304 (July 10).

ASSISTANT IN AERODYNAMICS—The Secretary of University Court, The University, Glasgow (July 14).

ASSISTANT IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (July 14).

ASSISTANT LECTURER (TAXONOMIST) IN THE DEPARTMENT OF BOTANY—The Registrar, University College of Wales, Aberystwyth (July 14).

DEMONSTRATORS (2) IN PHYSICS—The Registrar, College of Technology, Manchester 1 (July 14).

LECTURER IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Edinburgh (July 14).

CHAIR OF PHYSICS—The Registrar, The University, Birmingham 15 (July 15).

CHAIR OF PHYSIOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 15).

LECTURER (with a good honour degree, including heavy current subjects, together with reasonable industrial and teaching experience, and preferably with experience with any of the following: high tension testing; modern servo-mechanisms; heavy current analogue computers) IN ELECTRICAL ENGINEERING—The Secretary and Registrar, The University, Southampton (July 15).

TUTORIAL RESEARCH STUDENT IN MATHEMATICS (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (July 21).

LECTURER (with qualifications in pure mathematics or applied mathematics) IN MATHEMATICS—The Registrar (Room 9 O.R.B.), The University, Reading (July 23).

LECTURER (with training or experience in one of the following fields: (a) hydraulics; (b) aerodynamics; or (c) hydrodynamics) IN THE DEPARTMENT OF FLUID MECHANICS—The Registrar, The University, Liverpool (July 23).

SENIOR LECTURER IN THE DEPARTMENT OF ELECTRONIC ENGINEERING—The Registrar, The University, Liverpool (July 28).

CHAIR OF PHYSICS at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER IN THE DEPARTMENT OF MATHEMATICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

LECTURER (preferably with a special interest in the history and philosophy of science) IN PHILOSOPHY at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 31).

SENIOR LECTURER (highly qualified in statistical theory and widely experienced in the application of statistics to practical problems) IN STATISTICS, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, July 31).

ASSISTANT (with a degree in science, preferably honours) IN THE CHEMISTRY DEPARTMENT at Auchincruive, Ayr, for work relating to the spectrographic analysis of agricultural materials—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (August 10).

PROFESSOR OF EDUCATION and HEAD OF THE DEPARTMENT OF EDUCATION—The Registrar, The University, Leeds 2 (August 15).

LECTURER IN MATHEMATICS; and a LECTURER IN STATISTICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 31).

SCHOLAR (with an honours degree in physics or mathematics) IN THE ASTRONOMICAL SECTION of the School of Cosmic Physics at Dunsink Observatory, for research in solar spectroscopy or stellar photometry—The Senior Clerk, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin (September 1).

LECTURER (with a good honours degree in zoology and preferably some research experience, not necessarily in the tropics) IN ZOOLOGY; and a LECTURER or SENIOR LECTURER (with a degree in agriculture (or equivalent qualification) and preferably some research experience in animal husbandry) IN ANIMAL HUSBANDRY, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (September 15).

ASSISTANT EXPERIMENTAL OFFICER (with experience in laboratory work, preferably biological) IN THE PHYSIOLOGY DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

ASSISTANT LECTURER, Grade B (honours graduate) IN PHYSICS—The Principal, Brighton Technical College, Brighton 7.

ASSISTANT PHYSICIST (Basic grade) at the Regional Radium Institute, Bradford—The Secretary, Royal Infirmary, Bradford.

DEMONSTRATORS IN (*a*) AGRICULTURAL BOTANY (preferably with an interest in plant physiology); (b) MICROBIOLOGY (with interests in dairying or soil microbiology); and (c) AGRICULTURAL CHEMISTRY (with qualifications in agricultural chemistry or chemistry)—The Registrar, The University, Nottingham.

LECTURER IN CHEMISTRY—The Secretary/Treasurer, Royal Technical College, Glasgow.

MECHANICAL and ELECTRICAL ENGINEERS (with, or obtaining, a first- or second-class honours degree or equivalent in mechanical or electrical engineering), for important projects at Ministry of Supply Establishments in the South of England, which include research and development on ram jet engines and gas turbine propulsive systems for supersonic speed; mechanical and electrical devices for projectiles and rockets; instrumentation; aircraft and aircraft equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.436/6A.

READER IN MARINE BIOLOGY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 31).

RESEARCH ASSISTANTS IN CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18.

SCIENTIFIC EXHIBITIONS ASSISTANT, Assistant Experimental Officer grade (with G.C.E. (advanced) in two scientific subjects or equivalent, and preferably with drawing office experience and an interest in display work), for work in the Publicity Section of the Department of Scientific and Industrial Research in London—C.M.956, London Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1.

SENIOR LECTURER IN PHYSIOLOGY AND PHARMACOLOGY at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR TECHNICIAN, Grade 1 (with a wide knowledge of histological techniques), IN THE MORBID ANATOMY DEPARTMENT, to be responsible for the routine work under the direction of a Chief Technician—The Secretary, St. Albans City Hospital, Normandy Road, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Zoological Society of London. Report of the Council and Auditors for 1955. Pp. iii+55+4 plates. (London: Zoological Society of London, 1956.) [184

Imperial Forestry Institute, University of Oxford. Thirty-first Annual Report, 1954–55. Pp. 32. (Oxford: Imperial Forestry Institute, 1956.) [184

Science Masters' Association. Report of Committee and Balance Sheet, 1955. Pp. 33. (London: Science Masters' Association, 1956.) [184

Department of Scientific and Industrial Research. Forest Products Research Bulletin No. 36: Meranti, Seraya and Allied Timbers. By J. D. Brazier. Pp. vi+37+4 plates. (London: H.M. Stationery Office, 1956.) 2*s*. 6*d*. net. [184

Building Research Station Digest No. 86: Damp-proof Treatments for Solid Floors. Pp. 5. (London: H.M. Stationery Office, 1956.) 3*d*. net. [184

Admiralty Bulletin No. 76: The Tidal Branch of the Hydrographic Department of the Admiralty (Part 2). By Commander W. I. Farquharson, R.N. Pp. 5. (London: Admiralty, 1956.) [184

British Electrical and Allied Industries Research Association. Technical Report N/T71: A Study of Domain Structures in Alnico. By Prof. L. F. Bates and Dr. D. H. Martin. Pp. 5+5 plates. 7*s*. 6*d*. Technical Report Z/T100: Atmospheric Freezing, Pulsations and Evolutionary Progression in the Long-Period Variable Stars. By Dr. C. E. R. Bruce. Pp. 5. 4*s*. 6*d*. (Leatherhead: British Electrical and Allied Industries Research Association, 1956.) [184

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1956. No. 1: Fluorocarbon Derivatives. By Dr. R. N. Haszeldine. Pp. ii+49. (London: Royal Institute of Chemistry, 1956.) [184

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 959, Vol. 249 (19 April 1956): The Asymptotic Solution of Linear Differential Equations of the Second Order in a Domain Containing One Transition Point. By F. W. J. Oliver. Pp. 65–97. 11*s*. No. 960, Vol. 249 (19 April 1956): A Matrix Analysis of Processes Involving Particle Assemblies. By S. R. Broadbent and T. G. Calcott. Pp. 99–123. 10*s*. (London: Royal Society, 1956.) [184

Flora of Tropical East Africa. Connaraceae. Edited by Dr. W. B. Turrill and E. Milne-Redhead. Pp. 27. (London: Crown Agents for Oversea Governments and Administrations, 1956.) 3*s*. [244

Department of Scientific and Industrial Research: National Physical Laboratory. Notes on Applied Science. No. 13: Standard Capacitors and Their Accuracy in Practice. Pp. iv+10. (London: H.M. Stationery Office, 1955.) 1*s*. 3*d*. net. [244

Other Countries

East African Meteorological Department. Memoirs. Vol. 3, No. 4: Report on Experiments on Artificial Stimulation of Rainfall at Mityana, Uganda, September–December, 1954. By Dr. H. W. Sansom, D. J. Margman and G. England. Pp. 10. (Nairobi: East African Meteorological Department, 1955.) [64

New Zealand Forest Service. Bulletin No. 1: Forest Pathology in New Zealand. By J. J. de Gryse. Pp. vi+62+12 plates. Annual Report of the Forest Research Institute for the year ending 31 March 1955. By H. V. Hinds. Pp. 80. (Wellington: Government Printer, 1955.) [64

Administration Report of the Government Museum, Madras; the National Art Gallery, Madras; the Government Museum, Pudukkottai; and the Connemara Public Library (Exchange Section), Madras; for 1954–55. Pp. iii+46+2 plates. (Madras: Government Press, 1956.) [64

Western Region of Nigeria. Annual Report on the Forest Administration of the Western Region of Nigeria for the year 1953–54. Pp. 55. (Lagos: Government Printer, 1955.) [64

South Australia. Report of the Museum Board, 1st July 1954 to 30th June 1955. Pp. 11. (Adelaide: Government Printer, 1956.) [124

Testing of Agricultural Seeds Moving in International Trade: Proceedings of the Cambridge Conference, 18th June–3rd July, 1954. (Project No. 223.) Pp. 150. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1956.) 400 francs; 8*s*.; 1.25 dollars. [124

World Health Organization. Monograph Series. No. 30: Yellow Fever Vaccination. By Smithburn *et al.* Pp. 238. (Geneva: World Health Organization; London: H.M. Stationery Office, 1956.) 15 Swiss francs; 25*s*.; 5 dollars. [184

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Technique. No. 48: l'Alimentation Minérale du Bétail au Congo Belge. Par Prof. L. Hennaux. Pp. 115+6 plates. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1956.) 160 francs. [184

Carnegie Institution of Washington. Year Book No. 54 (July 1, 1954–June 30, 1955), with Administrative Reports through December 9, 1955. Pp. xxxix+9+211+3 plates. (Washington, D.C.: Carnegie Institution of Washington, 1955.) Cloth, 1.50 dollars; Paper, 1 dollar. [184

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 37 (February 1956): Hospitalization of Men at the Working Ages. Pp. 12. (New York: Metropolitan Life Insurance Company, 1956.) [184

Survey of India. Technical Report, 1952 (From 1st April 1951 to 31st March 1952). Part 1: Topographical and Other Surveys. Part 2: Map Publication and Office Work. Pp. v+47+2 Index Maps. Rs. 6. 9*s*. 6*d*. General Report, 1952 (From 1st April 1951 to 31st March 1952). Pp. xi+78+6 Index Maps. Rs. 18. 28*s*. 3*d*. (Dehra Dun: Survey of India, 1955.) [184

Eighth Annual Report of the Pacific Marine Fisheries Commission for the year 1955. Pp. 16. (Portland, Oregon: Pacific Marine Fisheries Commission, 1956.) [184

Council of Scientific and Industrial Research. Field Research Institute, Manbhum. Report of Director for the year 1954–55. Pp. iii+37. (Manbhum, Bihar: Fuel Research Institute, 1955.) [184

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